QBC®
Centrifugal
Hematology Analyzer

MAINTENANCE MANUAL for the QBC® II Reader

Model No. 4477

Becton Dickinson
Primary Care Diagnostics
One Becton Drive, Franklin Lakes, New Jersey, U.S.A. 07417

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Manual No. 4477-502-000
Original Issue May 1990

ERRATA SHEET
to
Maintenance Manual for QBC® II Reader, Model 4477
(Manual No. 4477-502-000, dated May 1990)

Subject: Part Number Changes in "Section 7 Parts List"

Please change the Reorder No. and Engineering Part No. of items in "Section 7 Parts List" as follows:

- Page 7-7

Figure:		Reorder No.	Engineering Part No.
2 -	From:	4457-510-000	4457-510-000
	To:	4477-510-000	4477-510-000

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Figure 2 Ref. Desig:		Reorder No.	Engineering Part No.
- U2	From:	4277-611-001	4477-411-001
	To:	4477-610-001	4477-510-001

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Figure 3 Ref. Desig:		Reorder No.
- U1	From:	4277-610-000
	To:	4477-611-001

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MAINTENANCE MANUAL
for the
QBC® II Reader

Model No. 4477

1-800-631-8064

Becton Dickinson
Primary Care Diagnostics
One Becton Drive, Franklin Lakes, New Jersey, U.S.A. 07417

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The QBC System is protected by one or more of the following U.S. Patent Numbers: 4,027,660; 4,082,085; 4,007,396; 4,159,896; 4,156,570; 4,091,659; 4,141,654; 4,137,755; 4,181,609; 4,209,226; 4,190,328; 4,558,947; 4,567,754; 4,594,165; 4,683,579; 4,695,553; and 4,779,976; as well as many foreign patents. Other patents pending.

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SECTION 1. GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This maintenance manual provides service information and procedures for QBC_{II} Reader Model 4477, which is manufactured by Becton Dickinson Primary Care Diagnostics.

1.2 PURPOSE OF EQUIPMENT

The QBC_{II} Reader makes volumetric measurements of cell layers in centrifuged QBC blood tubes to provide the following quantitative hematology values:

- Hematocrit
- Platelet Count
- White Blood Cell Count
- Granulocyte Count (% and number)
- Lymphocyte/Monocyte Count (% and number)

The QBC_{II} Reader is the major test component of the QBC Centrifugal Hematology Analyzer System (Figure 1-1). The hematology values provided by the reader are obtained by aspirating a measured amount of whole blood into a special-purpose QBC tube into which a precision-molded float is inserted. The tube, capped at one end, is centrifuged at high speed, causing the packed cell layers in the buffy coat of the blood tube to expand around the float. A coated staining agent in the blood tube causes these expanded cell layers to fluoresce when exposed to blue-violet light inside the reader. The lengths of the differentially fluorescing cell layers are measured by the electro-optical micrometer system of the instrument. A microprocessor then converts these linear measurements into hematology counts.

1.3 EQUIPMENT SUPPLIED

The equipment supplied is the Becton Dickinson QBC_{II} Reader Model 4477. The reader is supplied with spare parts and test accessories, including a semiautomatic pipetter for filling QBC tubes with venous blood. Step-Down Transformer Model 4477-505-000 is supplied, where applicable, to reduce a 230 V, 50/60 Hz main to the 120 V required at the reader.

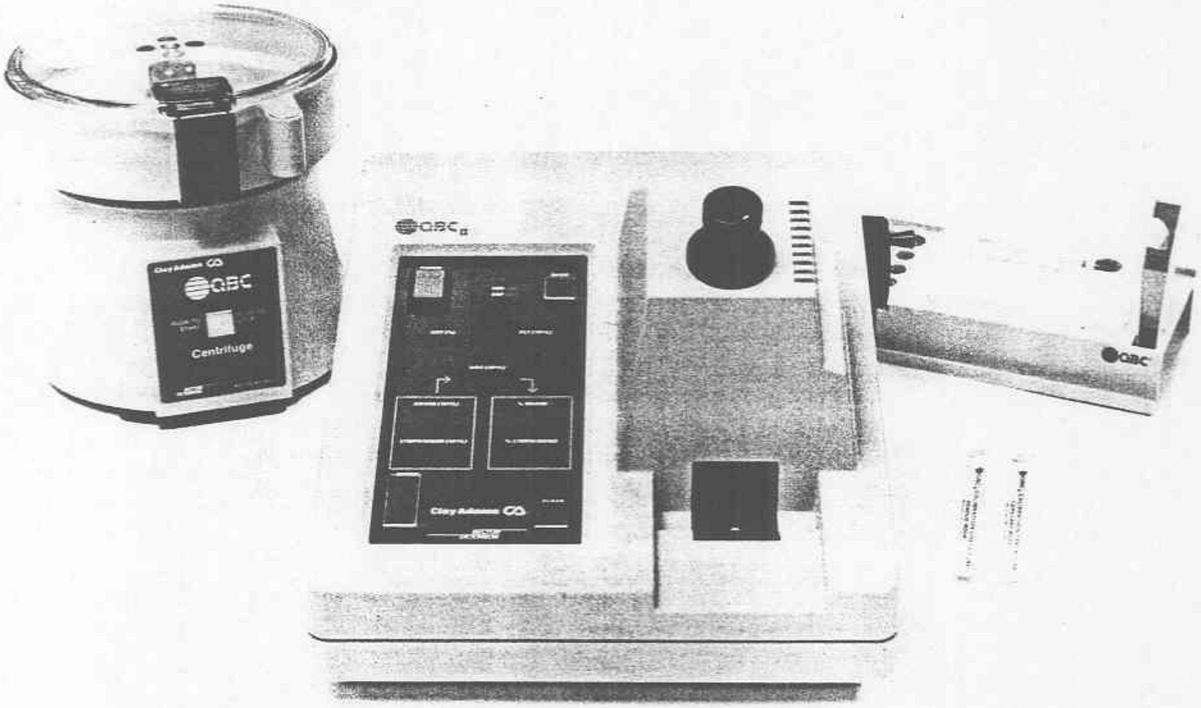


Figure 1-1. QBC Centrifugal Hematology Analyzer System.

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

A QBC Centrifuge Model 4207, QBC Work Station Model 4226, and QBC blood tubes are required for the reader to function as a QBC Centrifugal Hematology Analyzer System.

1.5 TECHNICAL CHARACTERISTICS

Technical characteristics of the reader are provided in Table 1-1.

TABLE 1-1. TECHNICAL CHARACTERISTICS OF READER

Characteristic	Description
Microscope:	
Type	Monocular.
Magnification	7.5 X.
Eyepiece	Adjustable.
Filter	Blue-violet/UV blocking.
Reflector	Acrylic beam splitter block.
Tube Rotation System:	
Type	Drum roller.
Roller Rotational Speed	250 RPM.
Tube Rotational Speed	1350 RPM.
Tube Carriage System:	
Type	Micrometer.
Drive	Manual by external transport knob linked to miter gears.
Pickup	Optical encoder.
Illumination System:	
Primary Light Source	Tungsten/halogen with condensing lens and filter for blue-violet illumination of blood tube.
White Light Source	Momentary, 5 volt tungsten lamp.
Reticle Arrow	Film/diffuser illuminated by 14 volt tungsten lamp.

TABLE 1-1. TECHNICAL CHARACTERISTICS OF READER (Cont)

Characteristic	Description
Power Requirements:	
Without step-down transformer	120 V ±10%, 50/60 Hz, 1.5 amp maximum, 0.4 amp typical (80W), single phase.
With step-down transformer	230 V ±10%, 50/60 Hz, 0.6 amp maximum, 0.2 amp typical (80W), single phase.
Fuse, main power	1.5 amp Slo-Blo (3AG)
Power cord	Two flat blades with ground pin, 2.0 m (6.5 ft) long.

1.6 PHYSICAL CHARACTERISTICS

Dimensions and weight of the reader and step-down transformer, both packed and unpacked, are given in Table 1-2.

TABLE 1-2. PHYSICAL CHARACTERISTICS

Characteristic	Weight (kg/lb)	Volume (m^3/ft^3)	Height (cm/in.)	Width (cm/in.)	Depth (cm/in.)
QBC$_{II}$ READER:					
Packed	12/26.4	0.12/4.2	44.5/17.5	54.6/21.5	49.5/19.5
Unpacked	8.3/18.4		25.6/10.1	33.8/13.3	36.5/14.4
TRANSFORMER:					
Packed	2.3/5.1	0.02/0.06	9.3/3.6	20.5/8.1	9/3.5
Unpacked	2.2/4.7		9/3.5	7.5/2.9	11.7/4.6

1.7 ENVIRONMENTAL REQUIREMENTS

The environmental requirements of the reader are given in Table 1-3.

TABLE 1-3. ENVIRONMENTAL REQUIREMENTS

Characteristic	Operating Limits	Storage Limits
Temperature	20° to 32°C 68° to 90°F	-26° to 55°C (-15° to 131°F)
Relative Humidity (Non-condensing)	10% to 95%	10% to 95%

1.8 ELECTROSTATIC DISCHARGE (ESD)

The QBC_{II} Reader contains printed-circuit boards on which metal-oxide-semiconductor (MOS) devices are installed. The MOS devices are subject to damage from electrostatic discharge.

Electrostatic discharge can occur at any time, but the probability of it occurring is increased when the humidity is low. The exercise of some simple precautions will minimize the likelihood of damage by ESD:

- Before handling the computer or printer circuit board, touch a grounded metal object, such as the centrifuge housing, to discharge electrostatic buildup from your body.
- Avoid touching, when possible, the MOS devices or their contacts.
- Stand on an anti-electrostatic mat to work on the circuit boards, and use an anti-static work surface.
- If the computer or printer circuit board is removed and is to be shipped, e.g., back to the factory, first place the printed-circuit board in an anti-electrostatic bag.

SECTION 2. INSTALLATION

2.1 UNPACKING

Examine the outer shipping container carefully to see if it has been damaged, e.g., punctured, dented at the corners, etc. Open the carton immediately if it is damaged, and inspect the equipment thoroughly for damage, such as dents or scratches. Notify the carrier if the equipment is damaged, and request a Damaged Equipment Report form.

The method of unpacking is shown by the exploded-view drawing in Figure 2-1. Unpack each carton as it is removed, and check its contents against the packing list, Table 2-1. Store the packing materials for possible future reuse.

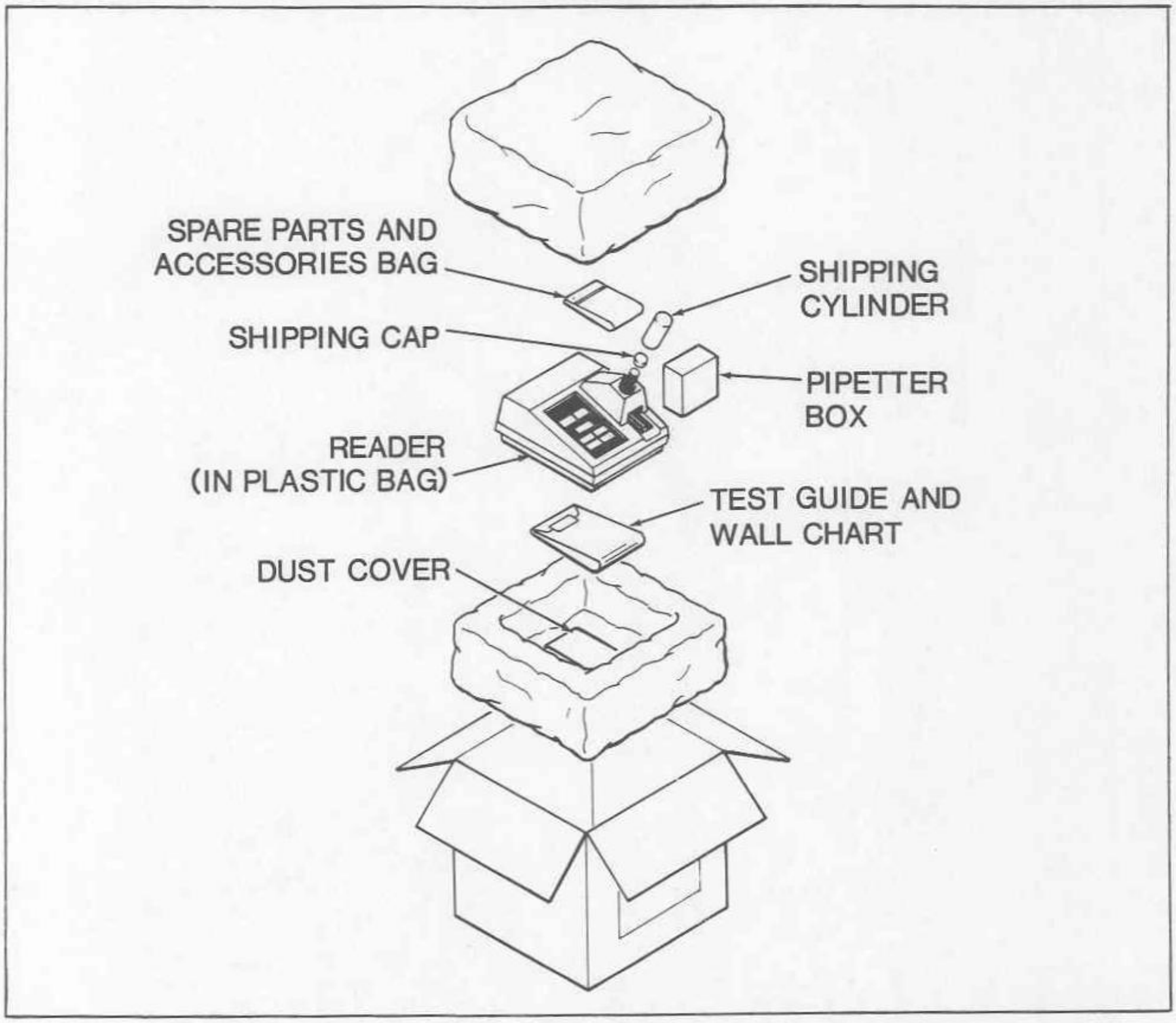

SPARE PARTS AND ACCESSORIES BAG
SHIPPING CYLINDER
SHIPPING CAP
PIPETTER BOX
READER (IN PLASTIC BAG)
TEST GUIDE AND WALL CHART
DUST COVER

Figure 2-1. Unpacking Diagram

TABLE 2-1. PACKING LIST

Item	Quantity
Reader Shipping Carton, contains:	
Plastic Bag, Spare Parts and Accessories:	
Calibration Check Tube, Venous Mode	1
Calibration Check Tube, Capillary Mode	1
Illuminator Lamp	1
Tube Lamp	1
Reticle Arrow Lamp	1
Forceps	1
Hex Key	1
Fuse, 1-1/2 amp Slo-Blo, 3AG, Spare	1
QBC_{II} Reader Assembly	1
Box Assembly, Pipetter:	
Venous-Blood Pipetter Assembly	1
O-Rings (set of 3)	1
Grease	1
Test Guide Card	1
Buffy Coat Analysis Chart	1
Dust Cover	1

2.2 ASSEMBLY PROCEDURE

Assemble the reader by performing the following procedure:

a. Remove and discard tape and protective sleeve from microscope eyepiece.

b. Remove microscope lens cover, and save it for reuse during extended period of reader idleness or storage.

c. Store QBC Pipetter in pipetter holder slot provided in QBC Work Station, Catalog No. 4226, which is provided with QBC_{II} system.

d. Save Test Guide and Buffy Coat Analysis Chart in a convenient place for use by operators and medical personnel.

2.3 READER LOCATION REQUIREMENTS

Locate the QBC_{II} Reader in a clean, dust-free area. Place the reader on a level table or counter surface. Avoid surfaces where there is noticeable vibration.

> **CAUTION**
>
> Location of reader is limited by location requirements of centrifuge. Centrifuge must be located where it will not be exposed to direct sunlight or intense light. Centrifugations in direct sunlight can elevate rotor temperature and may cause adverse effects on cell banding in QBC blood tubes.

2.4 AMBIENT TEMPERATURE

The QBC centrifugal tests must be performed in an area in which the ambient temperature is 20° to 32°C (68° to 90°F). (See Table 1-3.) Check to be sure that the day-to-day temperature in the selected test area remains within these limits. Test results may be erroneously high at temperatures below 20°C (68°F). Cell interfaces may become blurred and difficult to read above 32°C (90°F).

2.5 INPUT POWER REQUIREMENTS

The input power requirements of the reader are given in Table 1-1.

If the main power facility requires the reader to operate on 220/230/240 volts 50/60 Hz, a step-down transformer supplied with the reader should be used. Open and unpack the transformer carton, and plug the reader cordset into the receptacle on the transformer.

2.6 CABLE FABRICATION

There are no interconnecting cables between the reader and other items of the system.

SECTION 3. OPERATION

3.1 CONTROLS AND INDICATORS

External features of the QBC_{II} Reader are shown in Figure 3-1. Note that the mechanical system and the optical system are at the right, while electronic controls and indicators are on the control-display panel at the left. The transport knob is used to move the tube carriage assembly in and out under the microscope. The eyepiece of the microscope is used to focus it to suit the individual operator.

Controls and indicators on the control-display panel are shown in Figure 3-2 and are described in Table 3-1. Digital display devices are located beneath the panel, which is translucent to allow the displays to be read through the panel. The digital displays can be numeric characters, alphabetic characters, or both numeric and alphabetic characters.

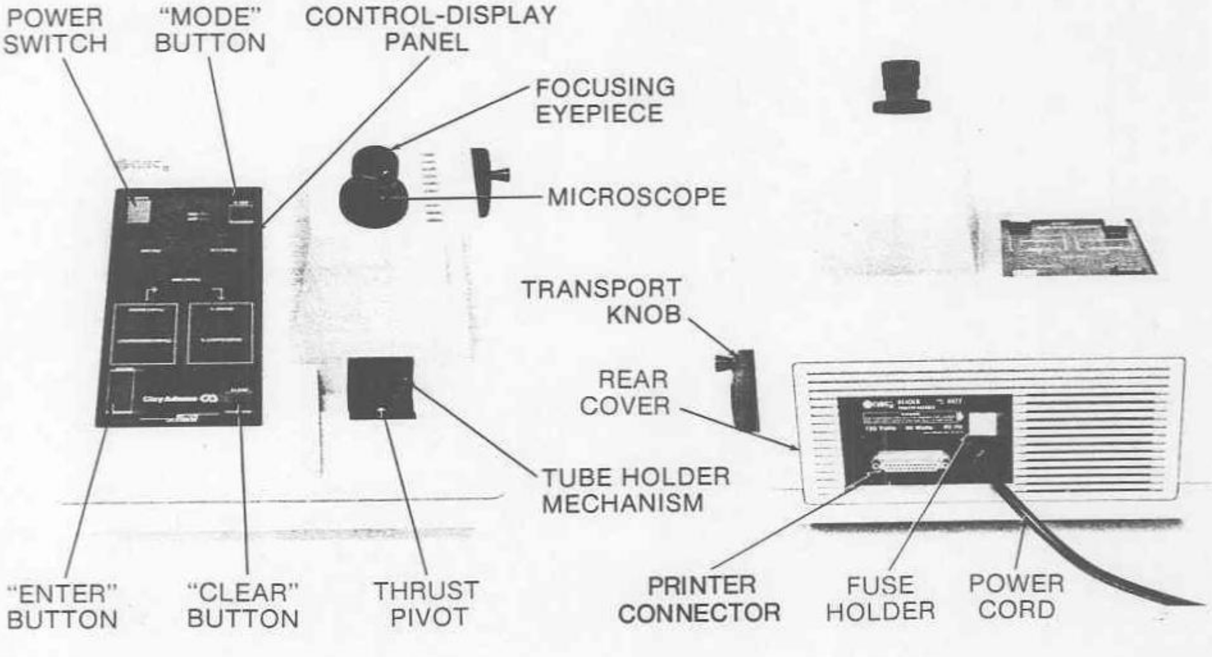

POWER SWITCH
"MODE" BUTTON
CONTROL-DISPLAY PANEL
FOCUSING EYEPIECE
MICROSCOPE
TRANSPORT KNOB
REAR COVER
TUBE HOLDER MECHANISM
"ENTER" BUTTON
"CLEAR" BUTTON
THRUST PIVOT
PRINTER CONNECTOR
FUSE HOLDER
POWER CORD

Figure 3-1. External Features of QBC_{II} Reader

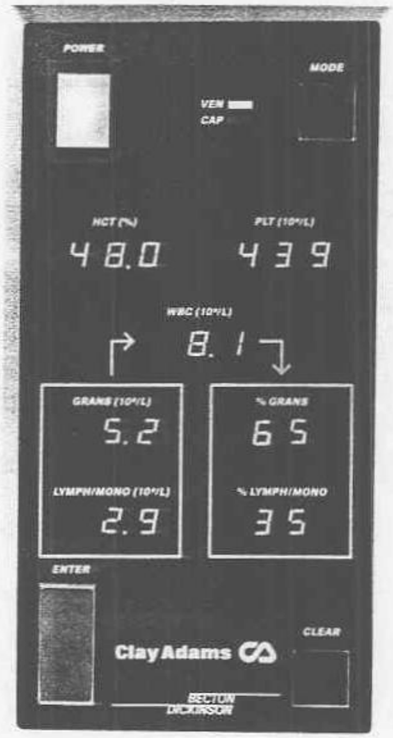

POWER
MODE
VEN
CAP
HCT (%)
48.0
PLT (10^9/L)
439
WBC (10^9/L)
8.1
GRANS (10^9/L)
5.2
% GRANS
65
LYMPH/MONO (10^9/L)
2.9
% LYMPH/MONO
35
ENTER
CLEAR
Clay Adams
BECTON DICKINSON

Figure 3-2. Control-Display Panel

TABLE 3-1. CONTROL-DISPLAY PANEL CONTROLS AND INDICATORS

Control/Indicator	Function
POWER switch	Push on/push off switch used to turn on/off power in reader and initiate self-test, an automatic sequence of digital indicators and microprocessor functions.
MODE switch	Push on/push off switch used to select type of blood test to be performed. VEN indicator is activated when switch is in, and reader is programmed for venous-blood tests. CAP indicator is activated when switch is out, and reader is programmed for capillary-blood tests.
ENTER switch	Momentary switch used to feed to microprocessor data denoting beginning and ending of each cell layer measurement.

CONTROLS AND INDICATORS (Cont)

Control/Indicator	Function
CLEAR switch	Momentary switch used to erase test values from digital displays, to initiate self-test sequence, and to reset reader for new blood tube test.
Seven segmented digital displays:	
HCT (%)	NN.N percent hematocrit.
PLT (10^9/L)	NN.N billion platelets per liter.
WBC (10^9/L)	NN.N billion white blood cells per liter.
GRANS (10^9/L)	NN.N billion granulocytes per liter.
% GRANS	NN percent granulocytes of total WBC.
LYMPH/MONO (10^9/L)	NN.N billion lymphocytes/monocytes per liter.
% LYMPH/MONO	NN percent lymphocytes/monocytes of total WBC.

The computer board (Figure 3-3) contains two 2-position slide switches. These switches are RAW COUNT switch S5 and UNITS switch S6.

Switch S5 is not to be used during operation; it is for use only by the factory or by an authorized service center. When this switch is in the ON position, it permits continuous display of "raw count measurements" in the PLT position. The displayed number indicates the counts or pulses (positive or negative) fed by the position encoder to the up/down counter since last resetting the counter to zero. Ensure that this switch is kept in the OFF (up) position.

Ensure that switch S6 on the computer boards of all QBC_{II} Readers is kept in the US (up) position.

3.2 MECHANICAL-OPTICAL SYSTEM

A centrifuged QBC blood tube is inserted into the tube carriage assembly (Figure 3-3). The blood tube is viewed through the microscope (Figure 3-4) as the blood tube is rotated about its longitudinal axis at approximately 1350 RPM. A motor-driven roller within the tube carriage assembly makes the tube rotate.

The tube carriage assembly can be moved axially, in and out, along a lead screw (threaded shaft) and guide rod. The lead screw can be turned, by means of miter gears linked to the external transport knob, to move the complete tube carriage assembly and rotating blood tube under the microscope lens. As the blood tube is moved, an optical encoder (position transducer) transmits electrical pulses proportional to the axial distance that the blood tube is moved.

An illuminator lamp continuously radiates blue-violet light through a condensing lens and filter at an excitation wavelength sufficient to cause the stained white cells and platelets to fluoresce. A barrier filter within the microscope effectively blocks the blue-violet rays from the viewer's eye. The tube lamp provides momentary auxiliary white light to illuminate the interface between the dark and light layers of red cells (second interface).

By rotating the blood tube around its longitudinal centerline, cell layer boundaries are viewed around their entire perimeters, and irregularities at the interfacing boundaries are averaged optically.

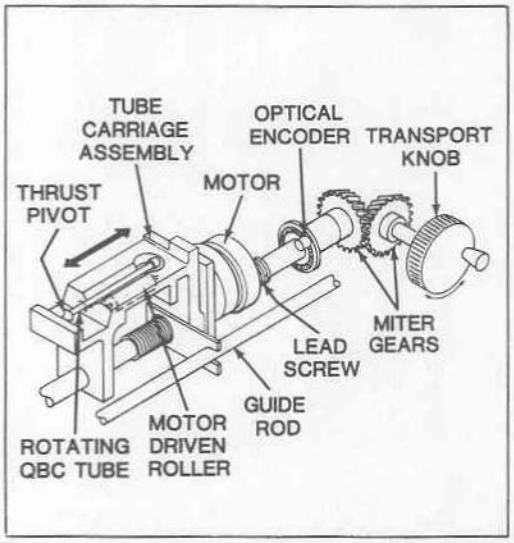

TUBE CARRIAGE ASSEMBLY
OPTICAL ENCODER
TRANSPORT KNOB
THRUST PIVOT
MOTOR
MITER GEARS
LEAD SCREW
GUIDE ROD
MOTOR DRIVEN ROLLER
ROTATING QBC TUBE

Figure 3-3. Tube Reader Mechanical System

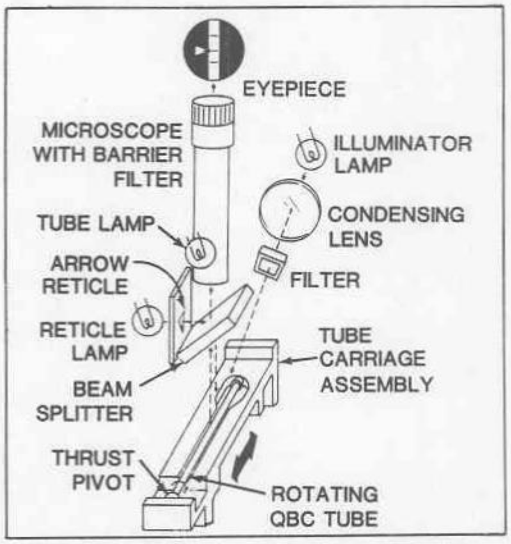

EYEPIECE
MICROSCOPE WITH BARRIER FILTER
ILLUMINATOR LAMP
CONDENSING LENS
TUBE LAMP
ARROW RETICLE
FILTER
RETICLE LAMP
TUBE CARRIAGE ASSEMBLY
BEAM SPLITTER
THRUST PIVOT
ROTATING QBC TUBE

Figure 3-4. Tube Reader Optical System

A stationary, backlighted reticle arrow (Figures 3-4 and 3-5) is provided in the optics system for aligning and "reading" of interfaces in the rotating blood tube. Starting at the first interface (I_1) at the closure-to-bottom of the dark red cell layer, lengths of the five packed cell columns (or plasma column in capillary tubes) are measured. See Figures 3-6 and 3-7.

As each interface is aligned with the reticle arrow, the ENTER switch on the control-display panel is pressed. Electrical pulses generated by rotational movement of the optical encoder are fed to a pulse counter and processed by the microprocessor, which computes values for the hematology parameters from lengths of the measured cell layers (or plasma column in capillary-blood tubes).

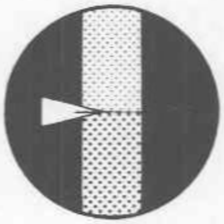


Figure 3-5. Reticle Arrow and QBC Tube
Viewed Through Microscope

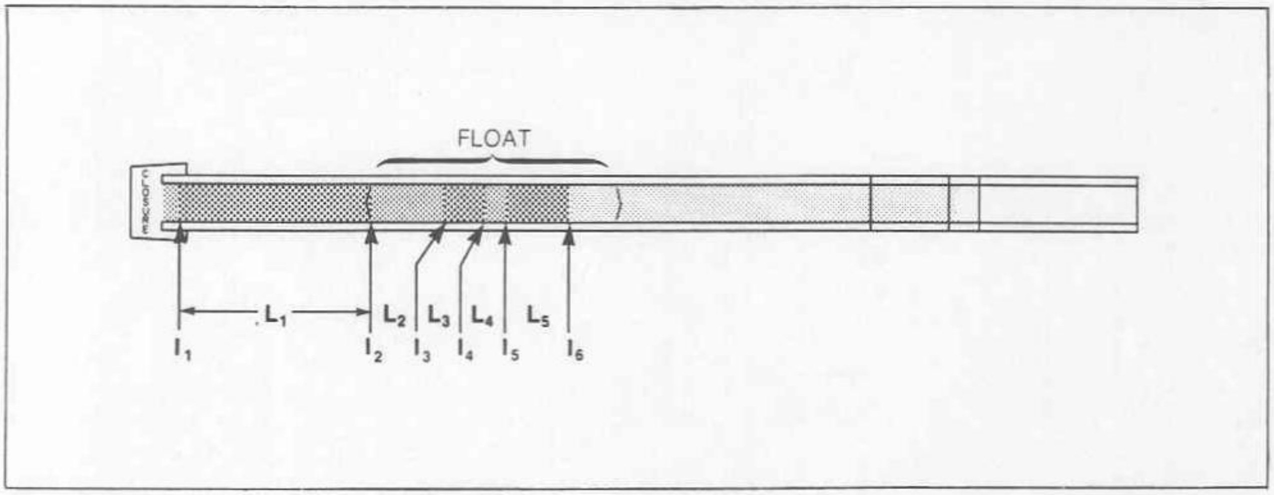


Figure 3-6. Layer Lengths Measured in QBC Venous-Blood Tube

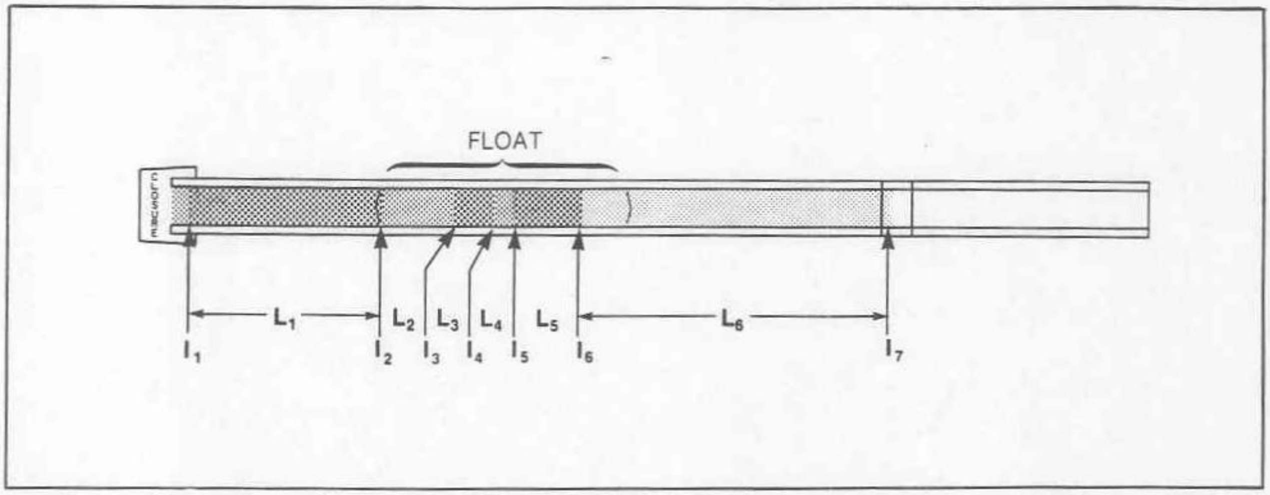


Figure 3-7. Layer Lengths Measured in QBC Capillary-Blood Tube

3.3 ELECTRONICS SYSTEM

The electronics system includes the optical (incremental position) encoder (Figure 3-3), which is mounted on the lead screw. The encoder produces two-phase electrical pulses proportional to the axial distance the blood tube is moved. An up/down counter converts the output pulses to a count proportional to the length of the cell layer being measured. The microprocessor uses fixed and programmable constants to calculate the cell counts. The ENTER switch controls operation of the counter and microprocessor. Except for the first interface, each time that ENTER is pressed, it signals the end of one layer measurement and be beginning of the next measurement. After the final interface has been read, the microprocessor displays the test results. Pressing the ENTER switch again - at the first interface of the next blood tube - clears the display automatically and resets the reader.

The microprocessor monitors the position of the MODE switch (VEN or CAP) and selects the correct program for computing test values from measurements of venous-blood or capillary-blood tubes. The

QBC_{II} hematology parameters are, quantitatively, a function of the following linear measurements (Figure 3-6):

- Hematocrit	L_1 and L_2
- WBC	L_3 and L_4
- GRANS	L_3
- LYMPH/MONO	L_4
- Platelet Count	L_5

Stored constants used in the electronic computation of hematocrit correct for the shrinkage of red cells due to potassium oxalate; volumetric expansion of the packed cells by the float; and float and closure geometry. Mean cell volumes and float expansion factors are applied in the WBC and platelet count computations. Derivation of test values from QBC capillary-blood tubes uses the same length measurements but different calculation functions based upon the length of plasma column L_6 (see Figure 3-7).

The microprocesssor controls the readout displays, internal tube light, and error detection systems. The error detection systems actuate service and procedure error "flags," which are displayed when an irregular condition is detected in the microprocessor memory or in the tube-reading procedure.

3.4 ERROR FLAGS

Error flags appear as flashing characters in the display windows on the control-display panel. Error flags that may appear and the causes of their appearance are described in Table 3-2.

Error flags P1 and P2 are, as defined in Table 3-2, service flags that may appear as the result of self-test failure. Self-test is initiated either by turning on power or by pressing the CLEAR switch. If one of the service flags is encountered, repeat (retry) the self-test several times. If the service flag disappears, it probably was due to a transient condition. If the service flag persists, it is the result of a catastrophic error condition; refer to the procedure in Paragraph 5.4.2 to correct the condition.

TABLE 3-2. ERROR FLAGS

Flashing Flag (Mode)	Display		Probable Cause of Error Flag
—L (VEN, CAP)	PLT	1.	Tube moved in wrong direction from last interface reading.
		2.	ENTER pressed twice while blood tube was at same interface, resulting in layer measurement of zero.
		3.	ENTER pressed twice at same interface to record length of "missing" white cell layer or platelet layer.
H2 (VEN, CAP) after entering 2nd interface	HCT	1.	Venous blood tube plasma-rich because specimen was not mixed before filling tube.
		2.	Float defective.
		3.	Insufficient specimen in blood tube due to filling error or blood loss.
H1 (VEN, CAP) after entering 3rd interface	HCT	1.	Float defective causing top of light red cell layer (L_2) to extend beyond top of float, preventing accurate HCT, WBC, and PLT.
		2.	High HCT or blood abnormality.

TABLE 3-2. ERROR FLAGS (Cont)

Flashing Flag (Mode)	Display		Probable Cause of Error Flag
L2 (VEN only) after entering 4th interface			High count or blood abnormality causing top of orange-yellow GRAN layer (L_3) to extend beyond top of float, preventing accurate WBC and PLT. Note that valid HCT value is displayed.
L2 (VEN only) after entering 5th interface			High count or blood abnormality causing top of green LYMPH/MONO layer (L_4) to extend beyond top of float, preventing accurate WBC and PLT. Note that valid HCT value is displayed.
L2 (VEN only) after entering 6th interface			High count or blood abnormality causing top of orange-yellow layer (L_5) of platelets to extend beyond top of float, preventing accurate WBC and PLT. Note that valid HCT, WBC, GRAN, and LYMPH/MONO values are displayed.
A8 (CAP only)	HCT	1.	Capillary blood tube contains too much specimen or not enough specimen.
		2.	High count or blood abnormality causing white cell or platelet layer to extend beyond top of float.
——— (VEN, CAP) over-range flag	HCT		High computed value exceeds dynamic capabilities of instrument, preventing display of HCT.
99.9 (VEN, CAP) over-range flag	WBC		Computed WBC exceeds three-digit limitation of reader display.

TABLE 3-2. ERROR FLAGS (Cont)

Flashing Flag (Mode)	Display	Probable Cause of Error Flag
999 (VEN, CAP) over-range flag	PLT	Computed PLT exceeds three-digit limitation of reader display.
P1 service flag	PLT	RAM check portion of self-test procedure failed. Computer circuit board defective.
P2 service flag	PLT	ROM check portion of self-test procedure failed. Computed checksum incorrect, ROM version mismatch. Computer circuit board defective.

3.5 STARTING

The reader is started by pressing on the green press on/press off POWER switch on the control-display panel. The lens of the switch illuminates when the reader circuits are powered on. The microprocessor initiates a self-test sequence when power is turned on. The simultaneous display by the digital indicators of all 8's, and decimal points where applicable, denotes that self-test is being performed.

3.6 OPERATING

3.6.1 INITIAL/DAILY CALIBRATION

Successful completion of the calibration checks verifies the ability of the reader to measure band lengths and to derive values within factory-set tolerances. Acceptable performance also confirms proper operation of the following primary electro-optical and computer components: tube position encoder, encoder-to-microprocessor data link, write-in/read-out functions of random-access memory (RAM), read-out function of read-only memory (ROM), software computation module, and the algorithms (venous and capillary) for computing HCT, WBC, GRANS, LYMPH/MONO, and platelet parameters at the specific assay levels (length measurements) defined by each calibration check tube. Proper functioning of switches, tube illuminator lamp, power supply, optics, displays, and mechanical components also are verified.

Separate calibration check tubes are provided with each QBC_{II} Reader to monitor the performance of the reader in the venous mode and the capillary mode. The calibration procedures are performed initially, to set up standards for each test mode, then daily to compare subsequent readings to the standard values obtained initially.

The following calibration checks must be performed before first use of calibration check tubes (at the time of initial installation of the reader) and before a replacement calibration check tube can be used. Initial values for the check tube must be established and recorded for each operator on the small sheet packaged with each check tube. The resulting recorded values and limits then are used by the operator at the start of each day's operation.

Proceed as follows:

a. Press POWER switch on control-display panel (Figure 3-2) to turn on reader.

b. Toggle MODE switch to VEN (venous-tube) mode.

c. Turn transport knob (Figure 3-1) counterclockwise until it stops and tube holder of carriage assembly is in fully down position (Figure 3-8).

d. Insert venous-blood calibration check tube into reader. Correct method is to hold tube near open end and insert closure end upward into tube carriage assembly (Figure 3-9); then gently lower and release tube so that open end of tube rests in center of thrust pivot.

> NOTE
>
> Tube transport knob (Figure 3-8) consists of small, protruding crank handle on larger knurled knob. Use crank handle for fast movement of tube holder, e.g., when lowering holder to remove blood tube or when moving tube inward to begin reading sequence. Use larger knurled knob for fine adjustment to align cell interface with reticle arrow.

e. Looking through microscope, use tube transport knob to move tube holder until first interface (junction of black and pale green), identified in Figure 3-10, aligns with reticle arrow; then press ENTER switch. Tube lamp will turn on.

f. Repeat Step e. using second interface. Tube lamp will turn off and will remain off for rest of interface readings.

g. Repeat Step e. using third through sixth interface. Seven values will be displayed when ENTER switch is pressed for last interface.

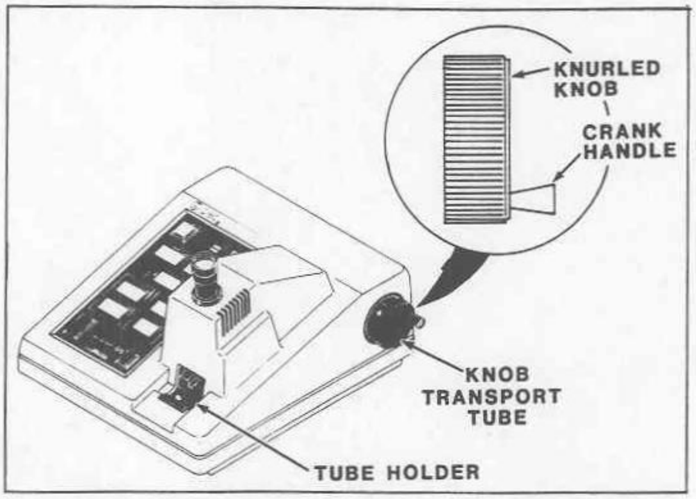

KNURLED KNOB
CRANK HANDLE
KNOB TRANSPORT TUBE
TUBE HOLDER

Figure 3-8. Tube Holder Shown in Down Position

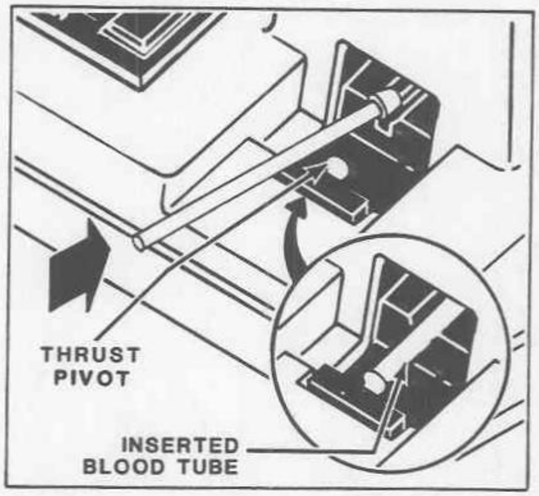

THRUST PIVOT
INSERTED BLOOD TUBE

Figure 3-9. Inserting Blood Tube into Reader

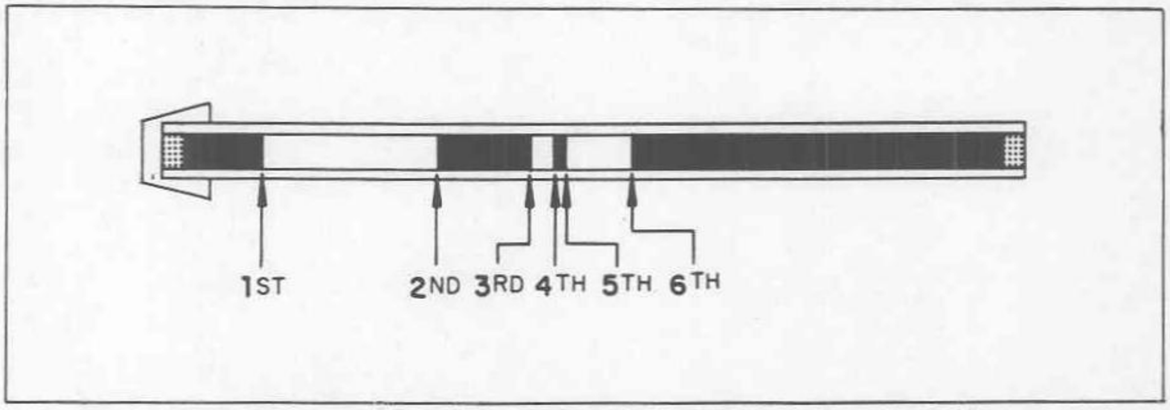

1ST
2ND
3RD
4TH
5TH
6TH

Figure 3-10. Venous Calibration Check Tube, Locations of Six Interfaces

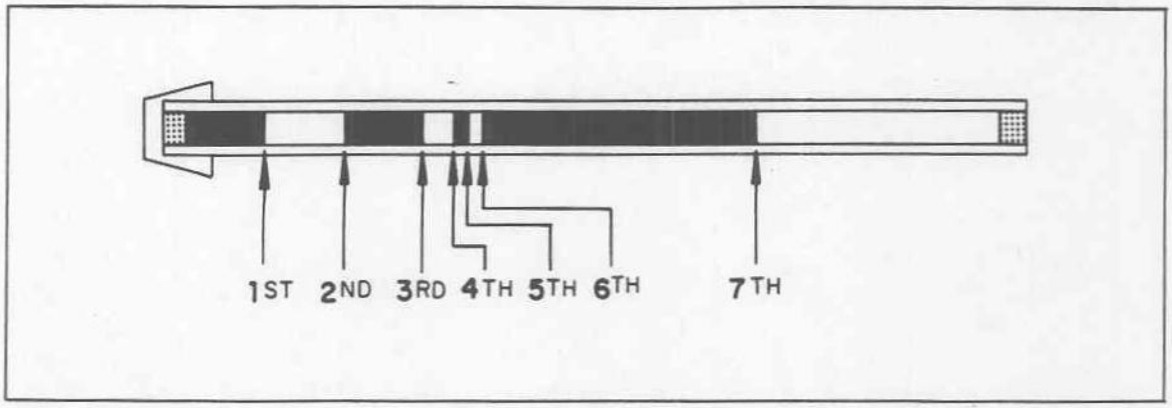


Figure 3-11. Capillary Calibration Check Tube, Locations of Seven Interfaces

h. If calibration check is being performed to set initial standards for first installation or for new calibration check tube:

1. Note all seven values.

2. Repeat Steps e. through h.1. to obtain 10 sets of seven readings.

3. Obtain average of 10 sets of readings, and compare averages with following ranges. Each average must be within specified range:

Indicator	Venous Mode	Capillary Mode
HCT	47.25-49.35	37.85-39.95
PLT	404-471	183-228
WBC	7.84-9.16	19.49-22.91
% GRANS	58-68	55-66
% LYMPH/MONO	32-42	34-45
GRANS (10^9/L)	4.85-5.87	11.58-14.08
LYMPH/MONO (10^9/L)	1.97-4.31	5.41-11.33

4. If all seven averages are within specified ranges, record each average as REFERENCE VALUE on small sheet packaged with venous check tube.

i. If calibration check is being performed as daily calibration check, compare each value obtained in Step g. with REFERENCE VALUE recorded on small sheet packaged with each check tube. Each value must be within following tolerance of value recorded in Step h.4. on small sheet packaged with check tube:

Indicator	Venous Mode	Capillary Mode
HCT	±0.15	±0.15
PLT	±7	±9
WBC	±0.20	±0.33
% GRANS	±3	±3
% LYMPH/MONO	±3	±3
GRANS (10^9/L)	±0.16	±0.38
LYMPH/MONO (10^9/L)	±0.10	±0.25

j. Turn tube transport knob counterclockwise to reset tube carriage assembly, and remove calibration check tube.

k. Toggle MODE switch to CAP (capillary tube) mode.

l. Insert capillary-blood calibration check tube into reader.

m. Refer to Figure 3-11, and repeat Steps e. through j.

n. Press POWER switch on control-display panel to turn off reader.

3.6.2 TESTING OF BLOOD SPECIMENS

Refer to operating procedures and precautions in the operator's manual and the maintenance manual for QBC Centrifuge Model 4207.

Refer to detailed operating procedures and precautions in the operator's manual for QBC_{II} Reader Model 4477. Refer also to the overview of operation in Paragraphs 3-1 through 3-3 of this maintenance manual.

3.7 STOPPING

The reader is stopped by pressing the green press on/press off POWER switch on the control-display panel.

3.8 QBC PIPETTER

The semiautomatic pipetter, shown stored in the Work Station in Figure 3-12, is a dedicated device for filling QBC venous-blood

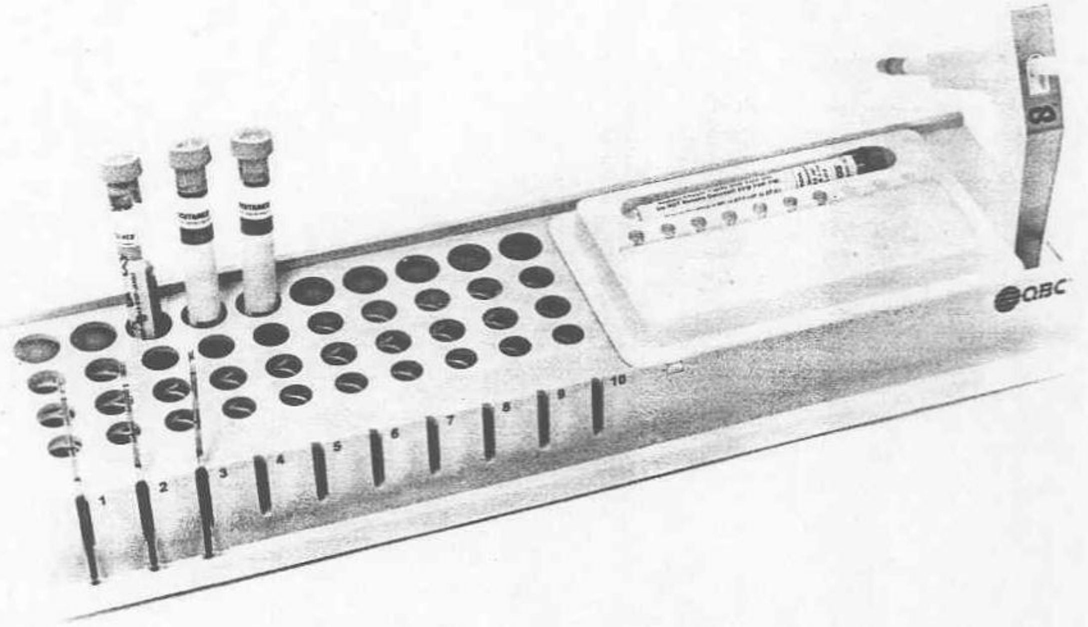


Figure 3-12. Venous-Blood Pipetter Shown in QBC Work Station

tubes. The plunger of the pipetter has two positions: fully retracted and fully depressed. When the pipetter is calibrated properly, fill volume is 111.1 microliters.

To fill a venous tube, press the plunger of the pipetter fully in until it stops (fill position); then insert the distal end of the tube into a well-mixed anticoagulated blood specimen. Release finger pressure smoothly until the plunger returns to its fully retracted position. Wipe excess blood from the outside surface of the tube with a lint-free tissue. Be careful not to touch the distal opening, which can result in the loss of specimen.

After each filling procedure, hold the pipetter so that the tube is horizontal, and check that the blood level is within 1 millimeter of the black line.

SECTION 4. THEORY OF OPERATION

4.1 BLOCK DIAGRAM

The electrical circuits of the reader are divided into the functional blocks identified in Figure 4-1. Figure 4-1 also shows the waveforms to be expected at the identified test points.

4.2 CIRCUIT OPERATION

Refer to the block diagram, Figure 4-1 and to the schematic diagram, Figure 8-1.

4.2.1 POWER SUPPLY

Both the fan and the rotator motor operate directly from the AC line, as does transformer T1. The secondary of T1 supplies 9 volts to the illuminator blue-violet lamp and to the reticle (arrow) lamp, which are on continuously when reader power is on.

The transformer secondary supplies 9 volts to full-wave bridge rectifier BR1, which provides a 10-volt DC output. The 10-volt output is filtered by C1 and C2 and applied to voltage regulator VR1. The VR1 output is 5 volts, which is used by the logic circuit. The regulator requires at least 2 volts differential for it to operate correctly; therefore, the input must be at least 7 volts to maintain the output at 5 volts.

There are two 5-volt outputs for distribution, the normal output and the low-noise output. The normal output generally is used as a supply for high-current devices, e.g., the seven-segment displays and the indicator lamps. The low-noise output is used for the microprocessor logic, the decoders, and the optical encoder.

4.2.2 SELF-TEST

When the reader is powered on or the CLEAR switch is pressed, the microprocessor performs its self-test sequence. This sequence includes RAM check, ROM check, and display check.

The random-access memory (RAM) is checked, byte by byte, by employing four patterns: all 0's (0000, 00 hexadecimal), all 1's (1111, FF hexadecimal), alternating 0's and 1's (0101, 55 hexadecimal), and alternating 1's and 0's (1010, AA hexadecimal). If there is a RAM failure, service error flag P1 is displayed in the PLT window.

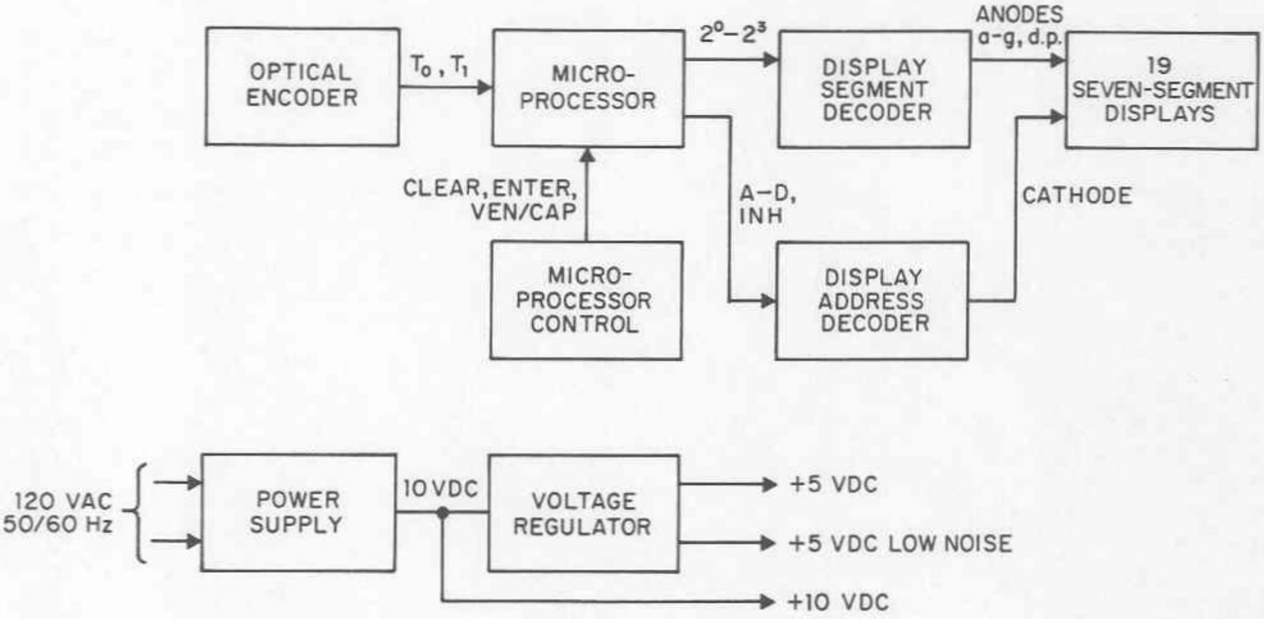

OPTICAL ENCODER
T_0, T_1
MICRO-PROCESSOR
$2^0 - 2^3$
DISPLAY SEGMENT DECODER
ANODES a-g, d.p.
19 SEVEN-SEGMENT DISPLAYS
CLEAR, ENTER, VEN/CAP
MICRO-PROCESSOR CONTROL
A-D, INH
DISPLAY ADDRESS DECODER
CATHODE
120 VAC 50/60 Hz
POWER SUPPLY
10 VDC
VOLTAGE REGULATOR
+5 VDC
+5 VDC LOW NOISE
+10 VDC

Figure 4-1. Simplified Block Diagram of Reader

The read-only memory (ROM) is checked in three ways: by reading the version number of the software in U2 on the computer circuit board, the version number in U1 on the printer circuit board, and then comparing the numbers for a match; by running a checksum on U1, which must equal 00; and by running a checksum on U2, which also must equal 00. If the version numbers fail to match or either checksum is not 00, service flag P2 is displayed in the PLT window.

The reader cannot be operated while a P1 or P2 error exists. Repeat the self-test several times. If the error flag persists, refer to the recovery procedure in Paragraph 5.4.2.

The self-test sequence also includes a display test. The digit 8, which employs all seven segments, is displayed simultaneously on all 19 digital indicators. The decimal point also is displayed where applicable. The display test is acceptable if 8's are displayed in all digit positions and decimal points are displayed in applicable digit positions.

4.2.3 OPTICAL ENCODER

Rotation of the transport knob on the right side of the reader turns the miter gear shaft to which it is attached. Turning the transport knob clockwise causes the distance from the prior position to be added; turning the knob counterclockwise causes the distance to be subtracted.

The miter gear on the shaft transmits the rotational motion of the transport knob via miter gears to the lead screw shaft to which the optical encoder is secured. The threads on the lead screw portion of the shaft cause the tube carriage assembly to move.

As the lead screw shaft turns, a disc in the encoder turns. The lines on the disc make and break a beam of light. The status of the light beam is sensed and is translated into two electrical outputs that are 90 degrees out of phase with each other. These outputs are square waves of voltage designated channel A and channel B (Figure 4-2), and their logical states are monitored at inputs T_0 and T_1 to the microprocessor.

Movement of the tube carriage assembly is sensed by the optical encoder. The pitch of the thread on the lead screw shaft and the spacing of the lines on the encoder disc are such that the logical state (waveform phase) of either channel A or channel B changes once for each 0.0005 inch of movement. The microprocessor counts the changes and stores the count for each

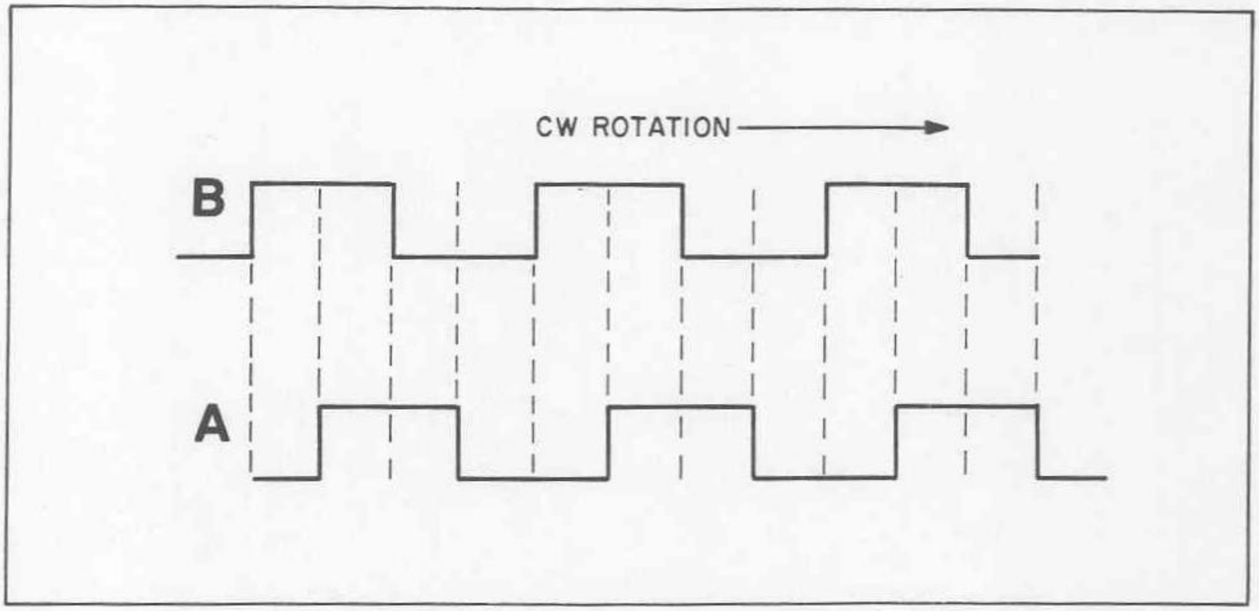


Figure 4-2. Optical Encoder, Timing Diagram

of the bands in the blood tube, i.e., counts since the last time that the ENTER switch was pressed.

4.2.4 MICROPROCESSOR

The QBC_{II} Reader is managed by microprocessor U2, an Intel 8749 device. All functions - including measurement of the bands, display of data, and the arithmetic computations - are accomplished by U2. The microprocessor contains 2 kilobytes of EPROM. Approximately half of the program instructions reside in U2; the other half of the instructions are contained in the type 8755 I/O expander, U1 on the printer circuit board. The computer circuit board connects via J6 and a short ribbon cable to J7 on the printer circuit board.

The microprocessor operates with a 6-MHz clock, controlled by the crystal between pins 2 and 3. It can be verified that the clock is operating by connecting an oscilloscope between XTAL pins 2 and 3 (sine wave) or at ALE pin 11 (square wave).

The microprocessor has a data bus (DB0-DB7) and two output ports, port 1 and port 2. The ports are 8-bit ports.

4.2.5 DISPLAYS AND DISPLAY CONTROL

4.2.5.1 Display Device Selection

Bits 0 through 4 of microprocessor port 1 (P_{10}-P_{14}) are used to select, one at a time, the 19 seven-segment display devices. The displays are multiplexed such that the displays turn on sequentially. (Only one device can be turned on at any given time.) A device is selected by turning on its cathode. The decoded outputs from U4 and U5 are supplied to U6 through U8, which drive the displays.

Bit 5 of port 1 (P14), the inhibit (INH) line, is used to determine whether 1-in-16 decoder U4 or decoder U5 is to be activated. Causing INH to go high inhibits the cathodes of the 16 displays controlled by U4 and enables selection of the three displays controlled by U5.

4.2.5.2 Display Segment Control

Figure 4-3 shows the segments of the display device and the lower-case alphabetic designations used on the schematic diagram to identify the segments.

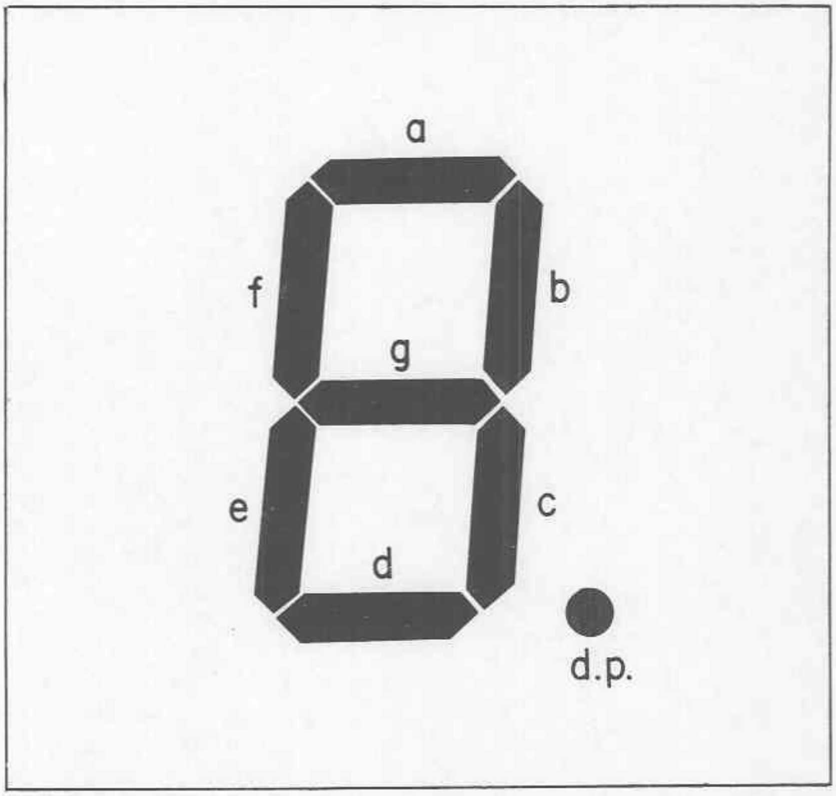


Figure 4-3. Display Segment Identification

Bits 0 through 3 of microprocessor port 2 (P_{20}-P_{23}) are used to select the segments to be actuated on the seven-segment displays. The four-bit code is sent to pins 2-5 of U9, a 4056 display driver functioning as a decoder, to enable a binary number between 0 and 15. The 16 possible binary numbers, therefore, make it possible to address the required segments for displaying numericcharacters 0 through 9 and alphabetic characters A, H, I, L, and P. Transistor arrays U10 and U11 provide the current-syncing capability necessary to run the displays. (U9 does not have enough syncing capability to handle the current needed to illuminate the seven-segment displays.)

Looking at the output at pin 9 of U9, which is the "a" segment, the output is amplified by U11 and is applied through a current-limiting resistor in RN6 to the "a" segment of all display devices. Assuming that the U30 cathode is energized (only one device can be turned on at any given time), the "a" segment of U30 will turn on.

The decimal point in U13 is turned on at any time that its cathode is energized. The decimal point in U19, U22, or U27 is turned on in the same manner as the segments, but the input is to the "d.p." pin of the display. The decimal point comes on automatically when the cathode is turned on.

Pin 31 of U2 is the inhibit (INH) line. When INH comes on, 1-of-16 decoder U4 is disabled while U5 is enabled. This arrangement results in multiplexing 16 lines (displays) from U4 while U5 is turned off; then U4 is turned off and U5 is turned on to multiplex the remaining three lines.

4.2.6 MISCELLANEOUS

4.2.6.1 Tube Lamp

Tube lamp DS3 (white-light) is turned on at blood tube interface I_1 and is turned off at blood tube interface I_2. The timing for DS3 operation is controlled by bit 7 of port 1 (P17) of the microprocessor. The lamp turns on when bit 7 goes high (1) and turns off when bit returns to low (0). Darlington transistor Q1 provides the high gain needed for this lamp circuit.

4.2.6.2 CLEAR Switch

CLEAR switch S3 activates the microprocessor reset (RES not) function by connecting ground (logical 0) to capacitor C19. Shorting the capacitor causes it to discharge to ground through resistor R6. The pull-up resistor for this circuit is in U2 and is connected internally to 5 volts. Capacitor C19 recharges through the internal resistor to a logical 1, releasing the reset condition.

4.2.6.3 VEN/CAP Mode Switch

VEN/CAP mode switch S4 is a push on/push off switch. Shorting switch pins 3 and 4 applies a logical 0 (ground) through the switch to pin 3 of inverter U3. Pin 2 becomes a logical 1, turning off transistor Q4 and turning off the VEN LED DS6(a-d), which means that the reader is in the capillary mode.

The logical 1 at pin 2 of U3 is the same as a 1 at pin 5 of U3. The inverter provides a 0 at pin 4, which sinks the base current of transistor Q3, turning on Q3 and CAP LED DS6(b-c). Because pins 1 and 2 of S2 are not shorted, bit 5 of port 2 on the microprocessor is pulled up to 5 volts through the resistor network RN1. A logical 1 at processor port 2 bit 5 equates to the capillary mode.

Pressing the VEN/CAP switch to the in position, ground is applied to bit 5 of processor port 2 as a logical 1, which the microprocessor equates to the venous mode. The logic works in reverse when pin 3 of inverter U3 goes high; the CAP LED is turned off and the VEN LED is turned on.

4.2.6.4 RAW COUNT Switch

The RAW COUNT slide switch, S5, is used only for test purposes, not by the customer. Turning on this switch causes the raw count to be displayed in the platelet (PLT) window of the control-display panel. The microprocessor recognizes a 1 at bit 7 of port 2 as raw count off or a 0 as raw count on.

4.2.6.5 ENTER Switch

The default condition at pin 6 of the microprocessor (interrupt, INT-not) is the pin connected through resistor network RN1 to 5 volts (logical 1). Pressing ENTER switch S2 connects ground (logical 0) to the interrupt (INT not) line of the microprocessor. This input initiates an interrupt, and any other operation in progress is stopped. The microprocessor then does an interrupt service routine, which is the operation with the highest priority. In this case, the highest priority is the reading of the counter associated with the optical encoder to determine the number of counts since the last entry.

SECTION 5. MAINTENANCE

5.1 TEST EQUIPMENT

The test equipment required, or equivalent, to maintain the QBC_{II} Reader is listed in Table 5-1.

TABLE 5-1. TEST EQUIPMENT REQUIRED

Equipment	Manufacturer	Use
Multimeter AN/USM-303A	Western Reserve Electronics Model 300MA	General use for voltage and resistance checks
Oscilloscope OS-262(P)/U	Tektronix 7623A	Waveform measurements
Plug-in Unit, Dual Trace TD-1159/U	Tektronix 7B53	Extension of oscilloscope capabilities
Amplifier, Dual Trace AM-6785/U	Tektronix 7A26	Extension of oscilloscope capabilities
Strobe with Power Supply	Pioneer Electric and Research Co., Model DS-303	Checking speed of drum rotor
Calibration Check Tube, Venous Mode	Becton Dickinson P/N 4235-000-000	Performance checks
Calibration Check Tube, Capillary Mode	Becton Dickinson P/N 4236-000-000	Performance checks

5.2 SPECIAL TOOLS

Special tools and fixtures required to maintain the QBC_{II} Reader are listed in Table 5-2.

TABLE 5-2. SPECIAL TOOLS REQUIRED

Tool/Fixture	Manufacturer	Use
Hexagonal (Allen) Wrench, 5/64 inch	(Supplied with reader)	Removal/replacement of transport knob
UV Alignment Tool	Becton Dickinson P/N 4460-600-000	Adjustment of illuminator lamp fluorescent pattern
Encoder Gapping Shim (0.010")	Becton Dickinson P/N 4477-551-000	Adjustment of encoder disc gap
Carriage Positioning Shim ().220")	Becton Dickinson P/N 4477-552-000	Adjustment of Carriage to frame gap
Switch Positioning Template	Becton Dickinson P/N 4477-553-000	Computer board switch location soldering
Rotator Adjustment Shim (0.015")	Becton Dickinson P/N 4477-554-000	Adjustment of roller drum on rotator shaft
Rotator Adjustment Shim (0.025")	Becton Dickinson P/N 4477-556-000	Adjustment of roller drum on rotator shaft
Miter Gear Shaft Height Gauge	Becton Dickinson P/N 4477-555-000	Adjustment of miter gears on transport
Pipetter Wrench	Becton Dickinson P/N 4225-602-000	Calibration of QBC Pipetter

5.3 PREVENTIVE MAINTENANCE

5.3.1 CLEANING

5.3.1.1 Optical Components

Glass lenses and other optical components are subject to normal accumulations of film and dirt that may eventually diminish the clarity of the blood tube and reticle arrow image. Periodic cleaning procedures follow.

5.3.1.1.1 Microscope Lenses

CAUTION

Clean surfaces of microscope lenses only with lens tissue or other cleaner recommended specifically for optical glass.

Proceed as follows to remove the microscope for cleaning access to the objective lens:

a. Disconnect power cord from wall/bench receptacle.

b. Refer to Figure 5-1, and remove split rubber collar from around microscope.

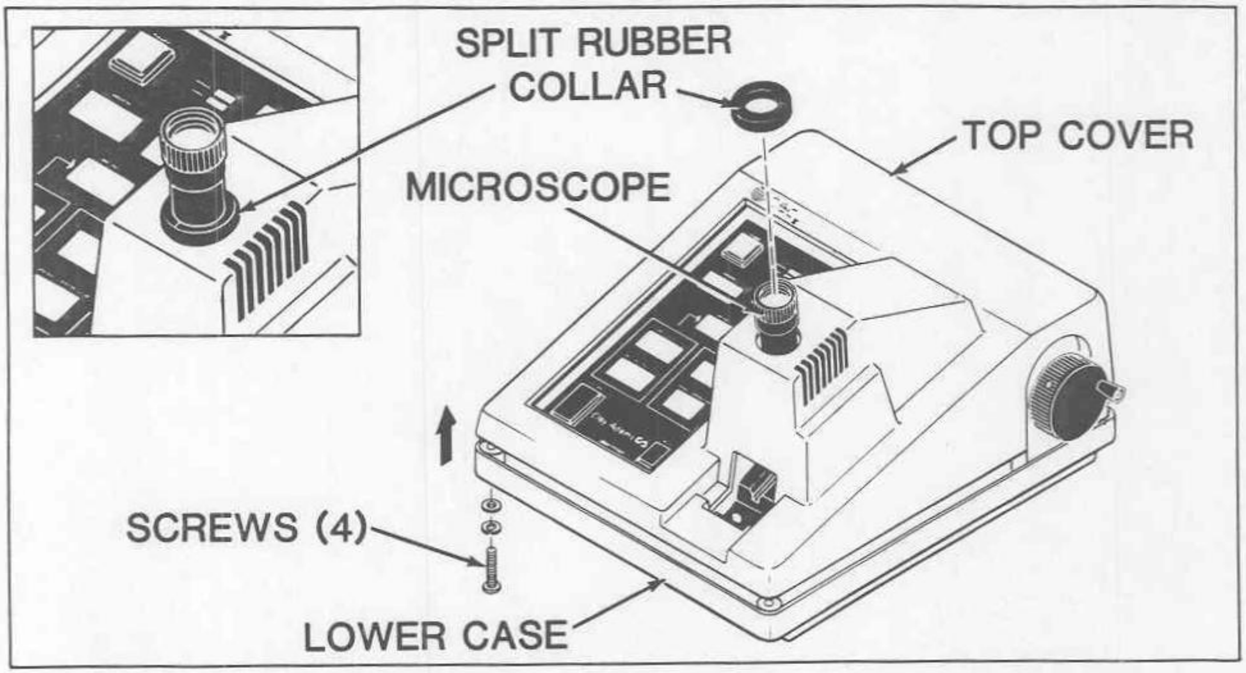

SPLIT RUBBER COLLAR
TOP COVER
MICROSCOPE
SCREWS (4)
LOWER CASE

Figure 5-1. Top Cover Removal Details

c. **Remove Phillips-head screws and washers from four corners of lower case. Lift cover to remove it.**

d. **Use pencil to mark barrel of microscope (Figure 5-2) at top of clamp.**

e. Loosen two bracket screws (Figure 5-2), and slide microscope out of clamp and bracket cushion.

f. Clean extended surfaces of eyepiece and objective lenses.

g. Reinstall microscope by lowering it into bracket to pencil mark made in Step e.

h. With bracket cushion in place, tighten bracket screws.

i. Replace top cover and microscope collar.

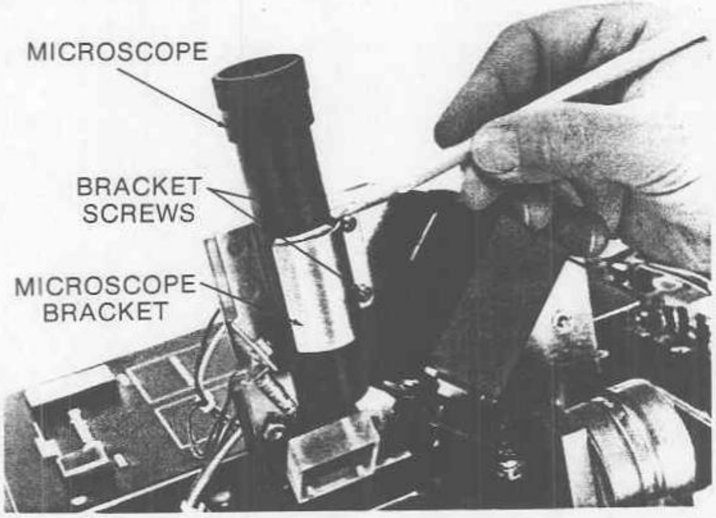


Figure 5-2. **Microscope Bracket Details**

5.3.1.1.2 **Beam Splitter**

With time, the beam splitter in the internal optics (see Figure 3-4) may require cleaning to maintain clarity and brightness of the blood tube image. Proceed as follows to gain access to the beam splitter:

a. Remove top cover and mark position of microscope by performing Steps a. through d. of procedure in Paragraph 5.3.1.1.1.

b. Loosen screws on microscope bracket, and slide microscope upward until beam splitter is accessible.

c. Clean upper and lower surfaces of beam splitter with dry cotton swab (Figure 5-3).

CAUTION

Be careful not to scratch polished surfaces.
Do not disassemble beam splitter.

d. Lower microscope into bracket to pencil mark made in Step a.

e. Replace top cover and microscope collar.

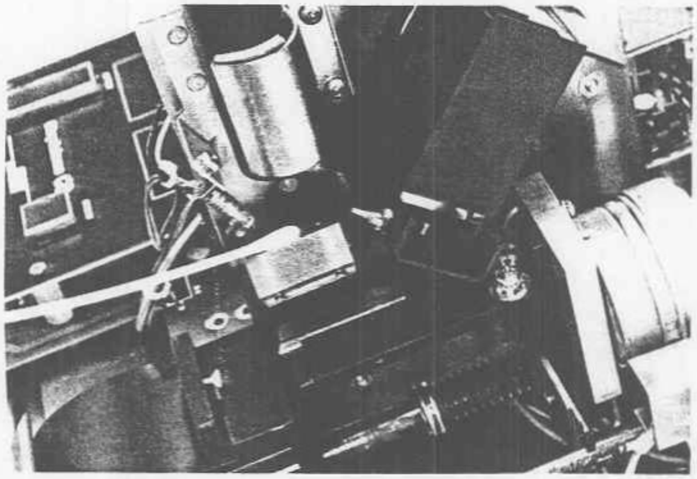


Figure 5-3. Cleaning Beam Splitter Block with Swab

5.3.1.2 Tube Roller

Debris and dried blood can accumulate on the drum-type tube roller through tube breakage and extended use. Excessive buildup of foreign materials eventually could cause the blood tube to jump or could cause the roller to turn at less than acceptable speed or to bind. Clean the roller periodically as follows:

6630-01-234-6793

a. Dip tip of long-shafted swab into isopropyl alcohol.

b. With tube roller spinning, gently wipe entire length of roller with swab. Also wipe left side of tube support as shown in Figure 5-4.

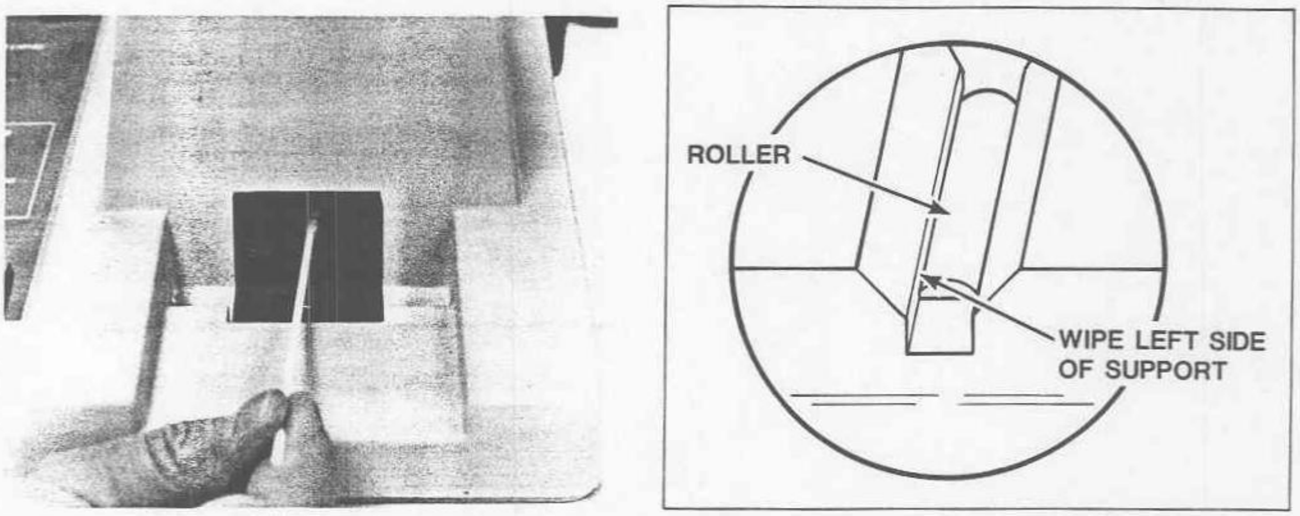


Figure 5-4. Cleaning Rotating Tube Roller with Alcohol Swab

5.3.2 LUBRICATION

Lubricate the internal lead screw and tube carriage components every 12 months or if the tube carriage fails to ride smoothly when the transport knob is turned. Proceed as follows:

a. Disconnect power cord from wall/bench receptacle.

b. Remove top cover by performing Steps b. and c. of procedure in Paragraph 5.3.1.1.1.

PSS Tulsa, Ok 918-251-7778

LEAD SCREW GREASE **CAUTION** $16.00 4242-0002

Use only Dow Corning Molykote Gn Paste, Becton Dickinson Part No. ~~4200-600-006.~~ Do not use any other lubricant, because lead screw may be damaged or may bind.

$27.80
PSS PART #
32834

c. Apply small daubs of Molykote Gn Paste at intervals along entire length of lead screw threads and extension shaft (Figure 5-5).

d. Rotate lead screw 1/4 turn and apply Molykote in small daubs, as in Step c.

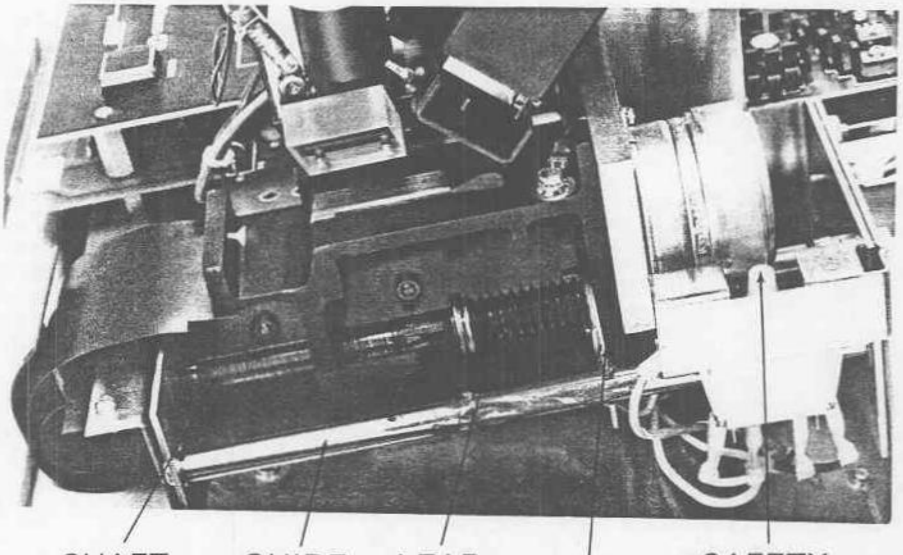

SHAFT EXTENSION
GUIDE ROD
LEAD SCREW
GUIDE
SAFETY INTERLOCK SWITCH

Figure 5-5. Lead Screw and Guide Rod

e. Repeat Step c. twice, each time applying Molykote.

f. Apply very thin, uniform film of Molykote to top and bottom surfaces of guide rod where guide surfaces touch rod.

g. Move mechanism back and forth against front and rear stops of lead screw several times to work Molykote into lead screw threads and extension shaft and along guide rod surfaces.

h. Replace top cover and microscope collar.

5.3.3 VISUAL INSPECTION

Perform the inspections described in Table 5-3 after the period specified and at any time that the reader is disassembled, such as after repair.

TABLE 5-3. VISUAL INSPECTIONS

Item	Inspection
Venous Calibration Check Tube (36 months)	Air bubbles caused by evaporation of fluid in tube.
Capillary Calibration Check Tube (36 months)	Air bubbles caused by evaporation of fluid in tube.
Rotator Drum (60 months)	Cracks in rubber (Replace rotator drum if cracks are noted.)
Shield (60 months)	Cracks or fractures in plastic. (Replace shield if cracks or fractures are noted.)
Heat Insulator (60 months)	Delamination of pressure-sensitive adhesive from aluminum or paper from adhesive. (Replace heat insulator if delamination is noted.)
Fan Gasket (60 months)	Deterioration of rubber. (Replace gasket if deterioration is noted.)
Display Panel Gasket (60 months)	Delamination of pressure-sensitive adhesive from rubber or paper from adhesive. (Replace gasket if delamination is noted.)
Microscope Clamp and Cushion	Separation of cushion from bracket. (Replace cushion if separation is noted.)
Wiring	Cables for frayed, pinched, or broken wires.
Computer Circuit Board	Resistors for charring or other evidence of overheating. Capacitors for leakage. Connectors for firm seating. Switches for smooth operation.

TABLE 5-3. VISUAL INSPECTIONS (Cont)

Item	Inspection
Printer Circuit Board	Resistor for charring or other evidence of overheating. Connectors for firm seating.
Cordset	Frayed, pinched, or broken wires. (Replace cordset if required.)
Pipetter (each filling operation)	Leakage of venous blood or failure to aspirate blood to within 1 mm of black line on QBC venous-blood tube.

5.3.4 PERIODIC CHECKS

5.3.4.1 Tube Roller Speed Check

Check the speed of rotation of the tube roller with a strobe by measuring the speed of the tube roller or by measuring the speed of a spinning blood tube. Nominal speeds and their tolerances for both methods are listed in Table 5-4.

TABLE 5-4. TUBE ROLLER SPEEDS

Type of Measurement	Speed at 60 Hz Power	Speed at 50 Hz Power
Roller drum	250 ±30 RPM	208 ±30 RPM
Blood tube	1350 ±200 RPM	1125 ±200 RPM

5.3.4.2 Encoder Output

Check the encoder every time that the top cover is removed to ensure that the encoder is operating correctly. While observing LED indicators LS4 and LS5 at right of RAW COUNT switch on the computer circuit board, slowly turn the transport knob counterclockwise. The LED's should flash in sequence.

5.3.4.3 Pipetter Filler Leakage

The QBC Pipetter is a precision device that has been factory-calibrated to aspirate 111.1 microliters of blood with an accuracy of 2%, which is approximately equivalent to 1 millimeter above or below the black fill line. After extended use, O-ring seals in the pipetter may become worn and require replacement. Replacement is indicated by failure of the pipetter to aspirate blood to within the 1-millimeter fill tolerance, or by leakage of blood from the distal end of the tube. A leakage check can be made by observing the blood level while holding the pipetter so that the blood tube is vertical. If the blood level drops 1 millimeter within about 30 seconds, the O-rings should be replaced. Spare O-rings are supplied with the pipetter.

5.3.5 MINIMUM PERFORMANCE STANDARDS

Minimum performance for the reader's electrical section is checked by the self-test sequence, the results of which are determined by limits built into the software of the microprocessor. Minimum performance for the optical and mechanical system are described in Table 5-5.

TABLE 5-5. MINIMUM PERFORMANCE STANDARDS

Item	Minimum Condition	Corrective Action	Paragraph Reference
Reticle Arrow	Bright and distinct (not fuzzy)	Align reticle lamp	5.4.1.1
		Adjust reticle arrow parallax	5.4.1.3
	Point of arrow overlapping check tube by 1/10 to 1/4 of tube's diameter	Adjust reticle arrow overlap	5.4.1.2
Illuminator Lamp	Intensity of fluorescent area evenly distributed around interface	Adjust lamp housing assembly	5.4.1.4

TABLE 5-5. MINIMUM PERFORMANCE STANDARDS (Cont)

Item	Minimum Condition	Corrective Action	Paragraph Reference
Tube Lamp	Light pattern centered around blood tube when viewed through microscope	Realign tube lamp bracket	5.4.1.5

5.4 CORRECTIVE MAINTENANCE

5.4.1 ADJUSTMENTS

> **WARNING**
>
> Some of the following adjustments must be made with the top cover off and the power on, which means that the interlock switch along the right side of the reader must be actuated. Be very careful when working under these conditions.

5.4.1.1 Reticle Arrow Brightness

The reticle arrow should be very bright when it is viewed through the microscope. Maximum brightness is attained only when the reticle lamp is aligned properly. Proceed as follows:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 5.3.1.1.1.

b. Loosen Phillips-head screw on bracket of reticle lamp socket assembly. (See Figure 5-6.) Leave screw finger-tight.

c. While looking through microscope, adjust reticle lamp socket assembly (up/down, left/right) until reticle arrow appears to be brightest.

d. Tighten screw on bracket of reticle lamp.

e. Replace top cover and microscope collar.

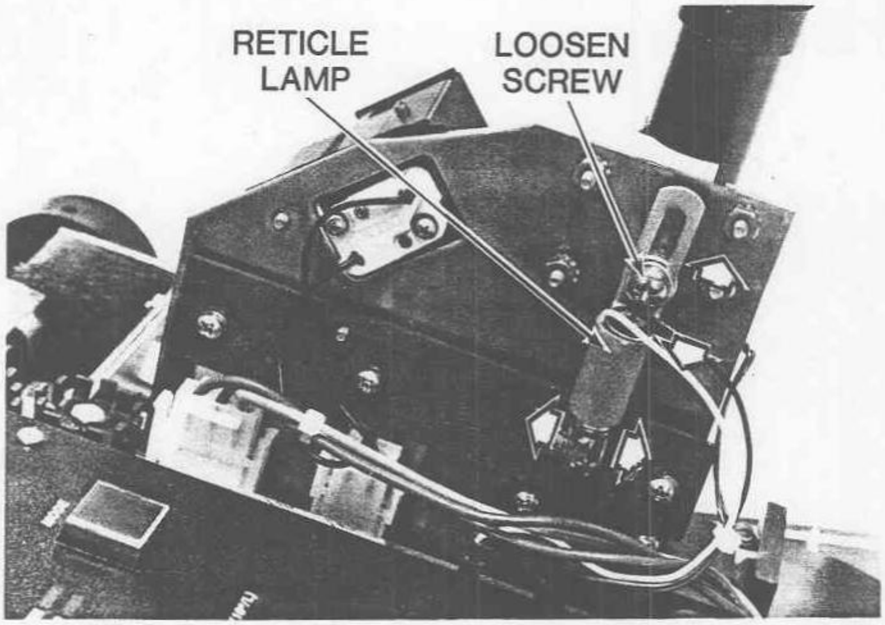


Figure 5-6. Reticle Lamp Alignment

5.4.1.2 Reticle Arrow Overlap

Proceed as follows with either venous or capillary calibration check tube inserted into the reader:

a. Near closure end of check tube, observe whether point of arrow overlaps tube by approximately 1/10 to 1/4 diameter of tube (Figure 5-7). If yes, adjustment is not required. If no, proceed to Step b.

b. Turn transport knob clockwise until reticle arrow is near open end of tube. Observe again whether point of arrow overlaps tube by approximately 1/10 to 1/4 diameter of tube. If yes, further adjustment is not required; if no, proceed to Step c.

c. Remove top cover by performing Steps a. through c. of procedure in Paragraph 5.3.1.1.1.

d. Connect and turn on power, and loosen two Phillips-head screws, marked "A" in Figure 5-8. Leave screws finger-tight.

e. While viewing calibration check tube at its two ends, as in Steps a. and b., adjust reticle bracket assembly 1/4 of diameter of tube at both ends of tube. Retighten "A" screws.

f. Replace top cover and microscope collar.

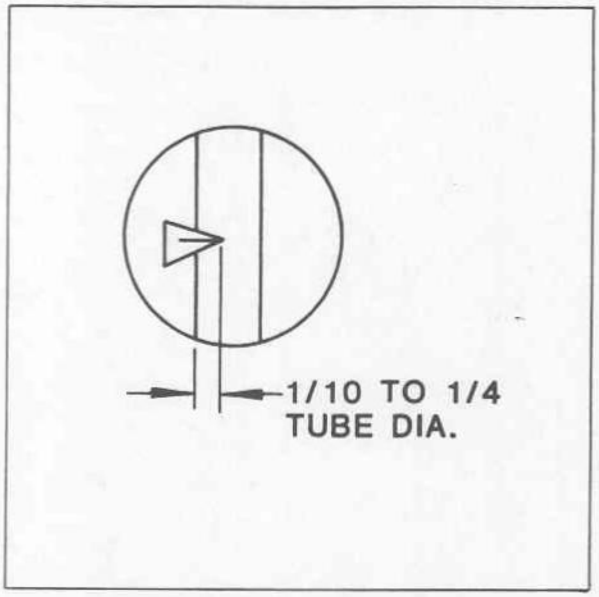


Figure 5-7. Overlap Tolerance of Reticle Arrow

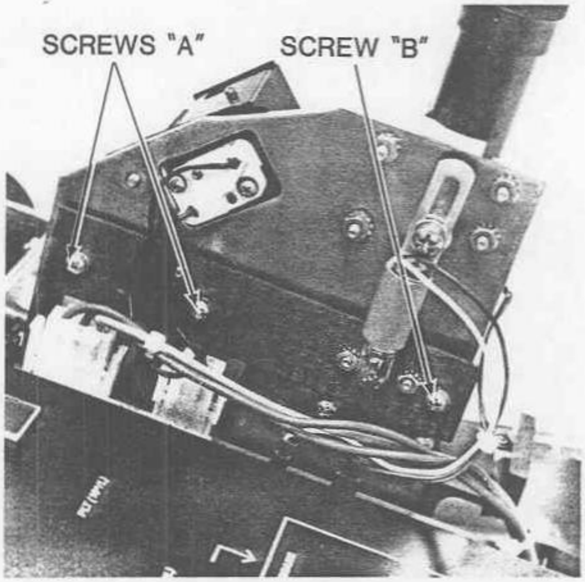


Figure 5-8. Reticle Arrow Adjustment

5.4.1.3 Reticle Arrow Parallax

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 5.3.1.1.1.

b. Ensure that microscope is set approximately 1-1/2 inches between bottom of objective lens and surface of tube carriage. (See Figure 5-9.) Loosen microscope bracket screws if necessary, and adjust height of microscope.

c. Turn on power, and press mode switch to VEN.

d. Insert venous-blood calibration tube into reader, and turn transport knob until reticle arrow points at any interface. Adjust microscope eyepiece so that image of calibration tube is sharp.

e. While still viewing tube at same interface, move eye up or down and observe that arrow tip and interface do not move independently of each other. If they move independently of each other, refer to Figure 5-8 and turn reticle arm screw "B" in or out (do not overshoot) until two images move together and parallax error is corrected.

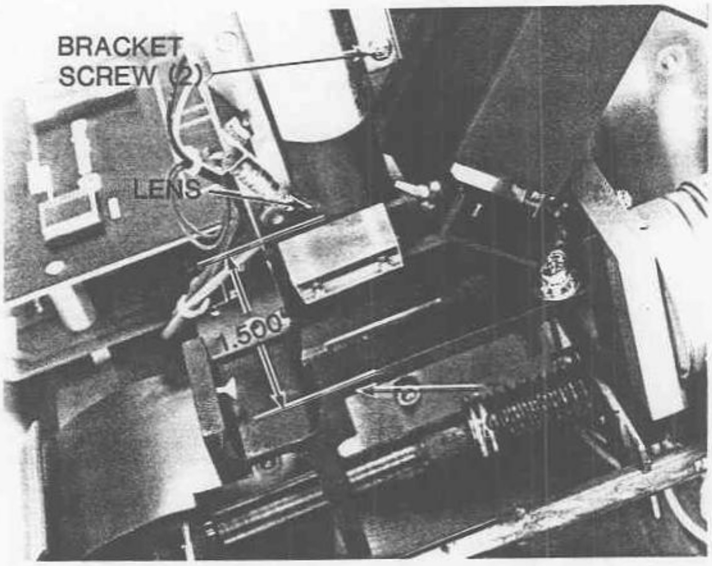


Figure 5-9. Height of Microscope Above Surface of Tube Carriage

> NOTE
>
> If reticle arm is deflected excessively by adjustment of screw "B" in Figure 5-8, arm may take a permanent set. In this case, re-bend arm to its original shape.

f. Apply Glyptal to nut and washer on screw "B" to lock zero-parallax setting.

g. Replace top cover and microscope collar.

5.4.1.4 Illuminator Lamp Light Distribution

The illuminator lamp should project a blue lighted area that is centered about the blood tube, i.e., the intensity of the lighted area is distributed evenly around the interface being examined. Before performing the procedure below, always check Reticle Lamp Overlap in accordance with Paragraph 5.4.1.2 and Reticle Arrow Parallax in accordance with Paragraph 5.4.1.3. Adjust as necessary; then check for illuminator light distribution.

Use UV Alignment Test Card Part No. 4460-600-000 to check light distribution as follows:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 5.3.1.1.1.

b. Remove display panel and computer circuit board by performing Steps a. through d. of disassembly procedure in Paragraph 9.3 of Section 9.

c. Disconnect two orange rotator motor wires from terminals on strip TB1 (Figure 5-10).

d. Replace computer circuit board, wire plugs if removed from circuit board connectors in Step b., and display panel. Note: Leave rotator motor wires disconnected.

e. Insert test card between roller and carriage (Figure 5-11), and adjust carriage up or down until black line on test card is in line with reticle arrow.

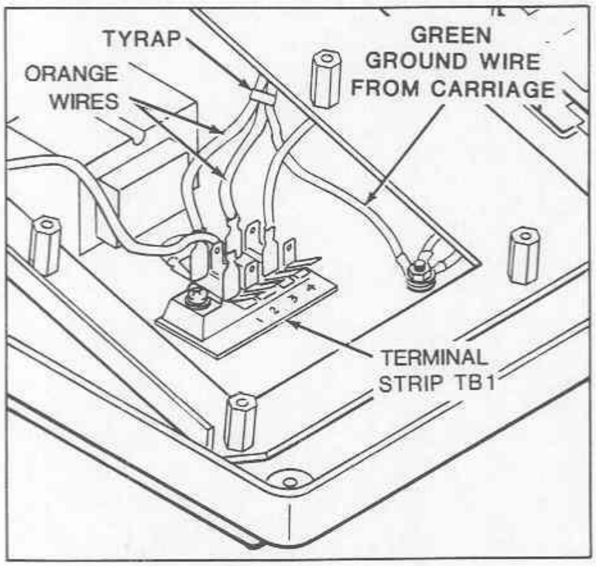

TYRAP
ORANGE WIRES
GREEN GROUND WIRE FROM CARRIAGE
1 2 3 4
TERMINAL STRIP TB1

Figure 5-10. Terminal Strip TB1, Showing Motor Wires

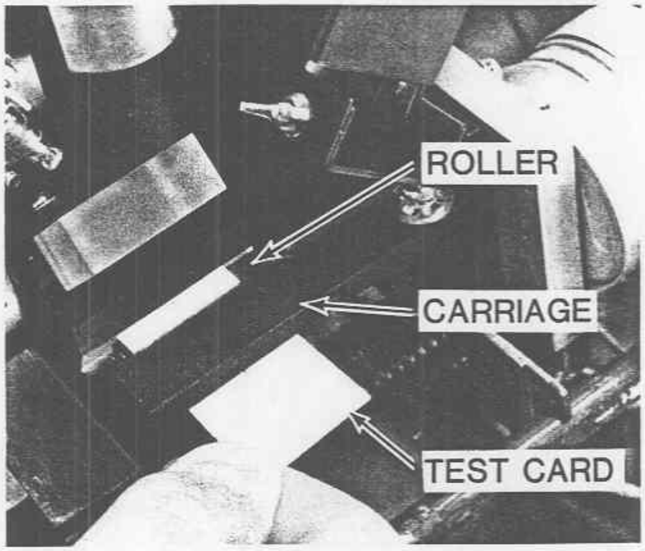

ROLLER
CARRIAGE
TEST CARD

Figure 5-11. Inserting Test Card into Reader

f. Observe blue area from illuminator lamp. If blue area is centered equally above and below black line on card, adjustment is not required; if not, proceed to Step g.

WARNING

Handle the illuminator lamp and lamp cover only with a protective cloth. The illuminator is extremely hot and will burn the hands.

g. Turn off and disconnect power. Loosen wing-nut (Figure 5-12), and remove cover of lamp assembly by sliding cover upward.

h. Verify that illuminator lamp is seated firmly in socket and is straight.

NOTE

If lamp is touched, use lens tissue and protective cloth to remove smudges.

i. Replace lamp housing cover, connect and turn on power, and look through microscope for distribution of blue light above and below black line. If light distribution is even, further adjustment is not required. If light distribution is uneven, proceed to Step j.

j. Remove test card, and insert calibration check tube. Move check tube until long white area is illuminated.

k. Determine whether blue area is centered equally left and right of tube. If yes, further adjustment is not required; if no, proceed to Step 1.

1. Loosen two Phillips-head screws, marked "A" in Figure 5-13. Leave screws finger-tight. Looking through microscope, adjust lamp housing assembly (with pliers if hot) until blue area is centered equally left and right of tube. Retighten screws.

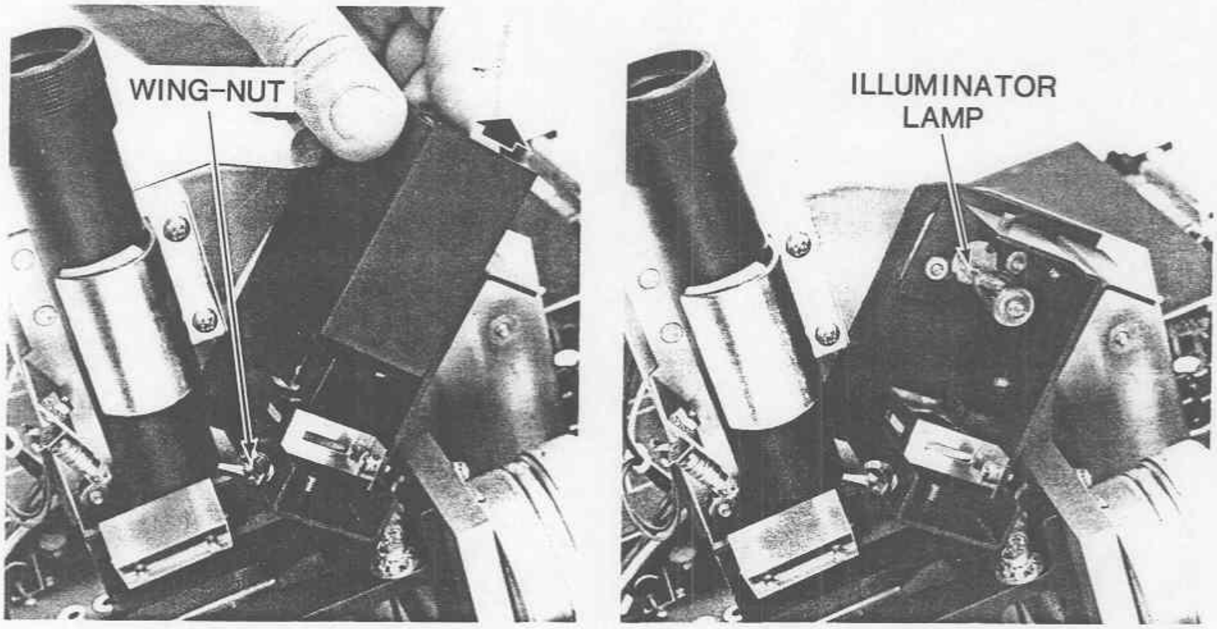

WING-NUT
ILLUMINATOR LAMP

Figure 5-12. Removing Illuminator Lamp Cover

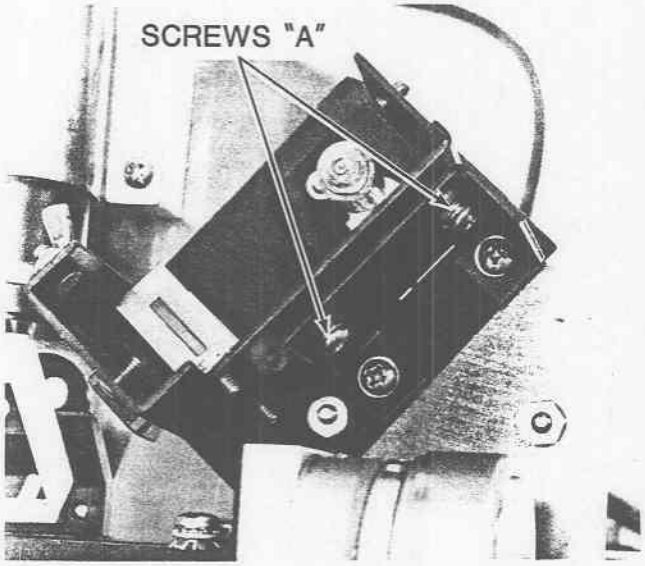


Figure 5-13. Horizontal Alignment of Illuminator Lamp Assembly

m. Remove calibration check tube. Re-insert test card between roller and carriage, and align black line with arrow.

n. Observe blue area from illuminator lamp. If blue area is centered equally above and below black line on card, adjustment is not required; if not, proceed to Step o.

o. Loosen two Phillips-head screws, marked "B" in Figure 5-14, which are accessible behind lamp housing assembly. Leave screws finger-tight. Looking through microscope, adjust lamp housing assembly vertically (with pliers if hot) until blue area is centered equally above and below black line. Retighten screws.

p. Turn off and disconnect power. Remove display panel and computer circuit board.

q. Reconnect orange rotator motor wires to terminals of TB1 (see Figure 5-10).

r. Re-install circuit board, display panel and top cover.

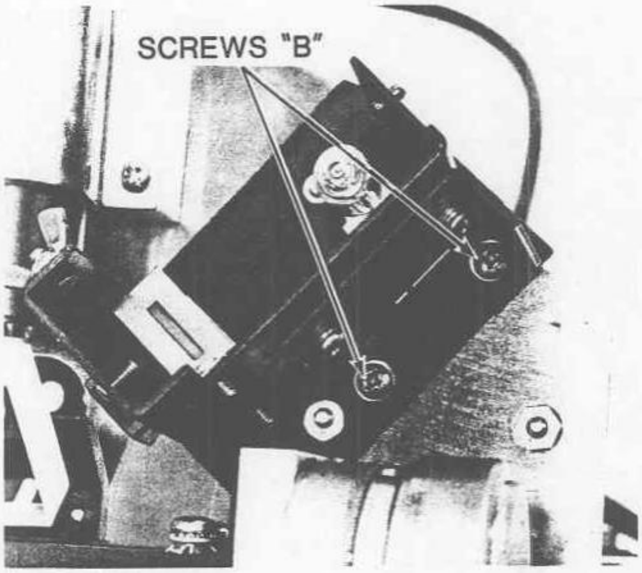


Figure 5-14. Vertical Alignment of Illuminator Lamp Assembly

5.4.1.5 Tube Lamp Light Distribution

The white-light oval pattern projected by the tube lamp (energized after entering the first interface (I_1)) should be centered around the blood tube when viewed through the microscope. If the blood tube is off-center, re-align it as follows:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 5.3.1.1.1.

b. Block ultraviolet light from illuminator lamp by covering lamp filter with black paper or cardboard.

c. Loosen Phillips-head screw that holds tube lamp bracket (Figure 5-15) in place. Leave screw finger-tight.

d. Connect and turn on power. Sequentially press CLEAR and ENTER switches once to activate tube lamp.

e. Looking through microscope, adjust tube lamp bracket left or right until white-light oval pattern is centered along tube as shown in Figure 5-16. Re-tighten bracket screw.

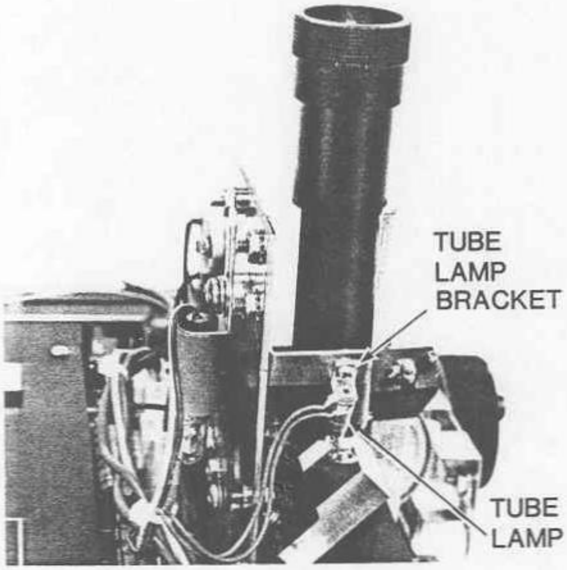


Figure 5-15. Tube Lamp Bracket

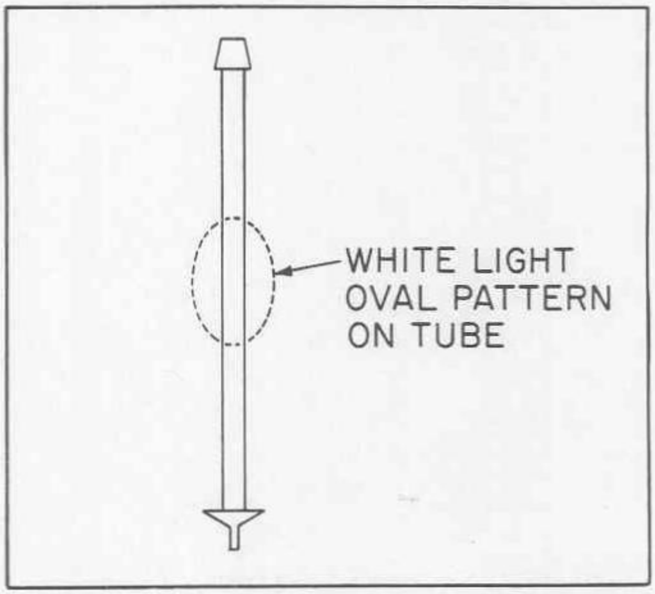


Figure 5-16. White-Light Oval Pattern on Tube

NOTE
Tube lamp may have to be rotated in bracket to obtain correct light pattern.

CAUTION
Take care when rotating bracket to prevent shorting of tube lamp wires.

5.4.1.6 Pipetter Fill Volume

A properly calibrated pipetter will aspirate 111.1 microliters of blood with an accuracy of 2%. If the pipetter fails to fill the QBC venous-blood tube to within 1 millimeter of the black fill line, the plunger stroke may require adjustment. The O-rings should be replaced before adjustment, however, and the pipetter should be retested for correction of the fill problem (see Paragraph 9.30).

If the fill problem persists, adjust the plunger stroke as follows:

a. Unthread tip assembly from body of pipetter (Figure 5-17).

b. Using pipetter wrench, turn adjustable stop to change stroke of plunger (Figure 5-18). Note that clockwise rotation of stop decreases plunger travel and decreases pipetter volume.

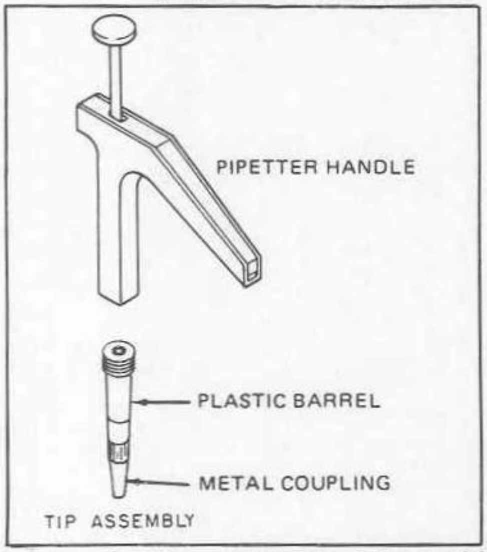


Figure 5-17. Separating Tip Assembly from Pipetter Body

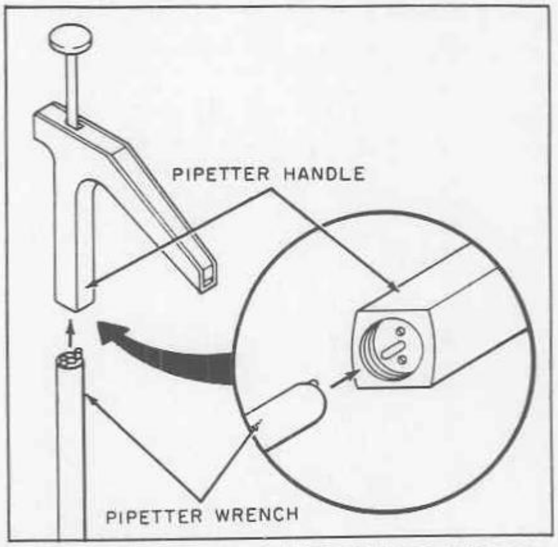


Figure 5-18. Adjusting Plunger Stop with Pipetter Wrench

c. Reinstall tip assembly, insert blood tube, and check to determine whether aspirated blood volume is within 1 millimeter of black fill line of QBC venous-blood tube.

d. Repeat Steps b. and c., if necessary, until fill volume is properly calibrated.

5.4.2 RECOVERY FROM P1 OR P2 SERVICE ERROR

The reader cannot be operated while a P1 (RAM) error or a P2 (ROM) error condition exists. Proceed as follows if a P1 or P2 error flag is displayed in the PLT window of the control-display panel:

a. **Repeat self-test several times, either by power off and then back on or by pressing CLEAR switch. If error condition disappears, assume that condition was caused by transients. If error condition persists, assume cause to be RAM (P1) failure or ROM (P2) failure, both of which are disabling failures.**

b. **Obtain matched set of devices** (same software version): Type 8749 microprocessor, U2 on computer circuit board; and Type 8755 EPROM-I/O, U1 on printer circuit board.

c. Remove device from socket XU2 on computer circuit board, and replace it with device from matched set (see Step b.).

d. Remove device from socket XU1 on printer circuit board, and replace it with device from matched set (see Step b.).

e. Verify that service error has been cleared by repeating self-test. Reader should be operable

5.4.3 VOLTAGES AND RESISTANCES

Only U2 on the computer circuit board and U1 on the printer circuit board are socketed. The expected on-terminal voltage and resistance values for U2 and U1 are shown in Tables 5-6 and 5-7, respectively, with the chips in place.

TABLE 5-6. COMPUTER CIRCUIT BOARD SOCKET U2, EXPECTED VOLTAGE AND RESISTANCE VALUES

Pin	Voltage (Volts)	Resistance (Ohms*)
1	0	>20M
2	2.18	420k
3	0.98	1.5k
4	4.87	20k
5	4.87	54.5k
6	4.91	6.3k
7	0	1.0k
8	3.77	>20M
9	3.77	>20M
10	3.77	>20M
11	0.80	>20M
12	0.20	>20M
13	0.36	>20M
14	0.36	>20M
15	0.36	>20M
16	0.35	>20M
17	3.19	>20M
18	0.32	>20M
19	0.32	>20M
20	0	0
21	4.60	5.3k
22	4.60	5.3k
23	4.60	5.3k
24	4.60	5.3k
25	3.62	>20M
26	4.91	>20M
27	2.44	5.3k
28	2.44	5.3k
29	1.96	5.3k
30	1.96	5.3k
31	1.01	5.3k
32	0	5.3k
33	0	840
34	0	3.1k
35	4.85	5.2k

TABLE 5-6. COMPUTER CIRCUIT BOARD SOCKET U2, EXPECTED VOLTAGE AND RESISTANCE VALUES (Cont)

Pin	Voltage (Volts)	Resistance (Ohms*)
36	4.88	3.1k
37	4.85	5.2k
38	4.88	3.11k
39	0	720M
40	4.90	620

* k = kilohms (X 10^3), M = megohms (X 10^6)

TABLE 5-7. PRINTER CIRCUIT BOARD SOCKET U1, EXPECTED VOLTAGE AND RESISTANCE VALUES

Pin	Voltage (Volts)	Resistance (Ohms*)
1	0	0
2	4.88	>20M
3	0.58	>20M
4	0	0
5	4.88	<20M
6	0	>20M
7	0	0
8	3.75	>20M
9	3.76	>20M
10		
11	0.85	>20M
12	0.08	>20M
13	0.25	>20M
14	0.24	>20M
15	0.24	>20M
16	3.14	>20M
17	0.22	>20M
18	0.20	>20M
19	3.10	>20M
20	0	0
21	4.56	5.35k
22	4.56	5.32k
23	4.57	5.30k
24	0.02	>20M
25	0.02	>20M

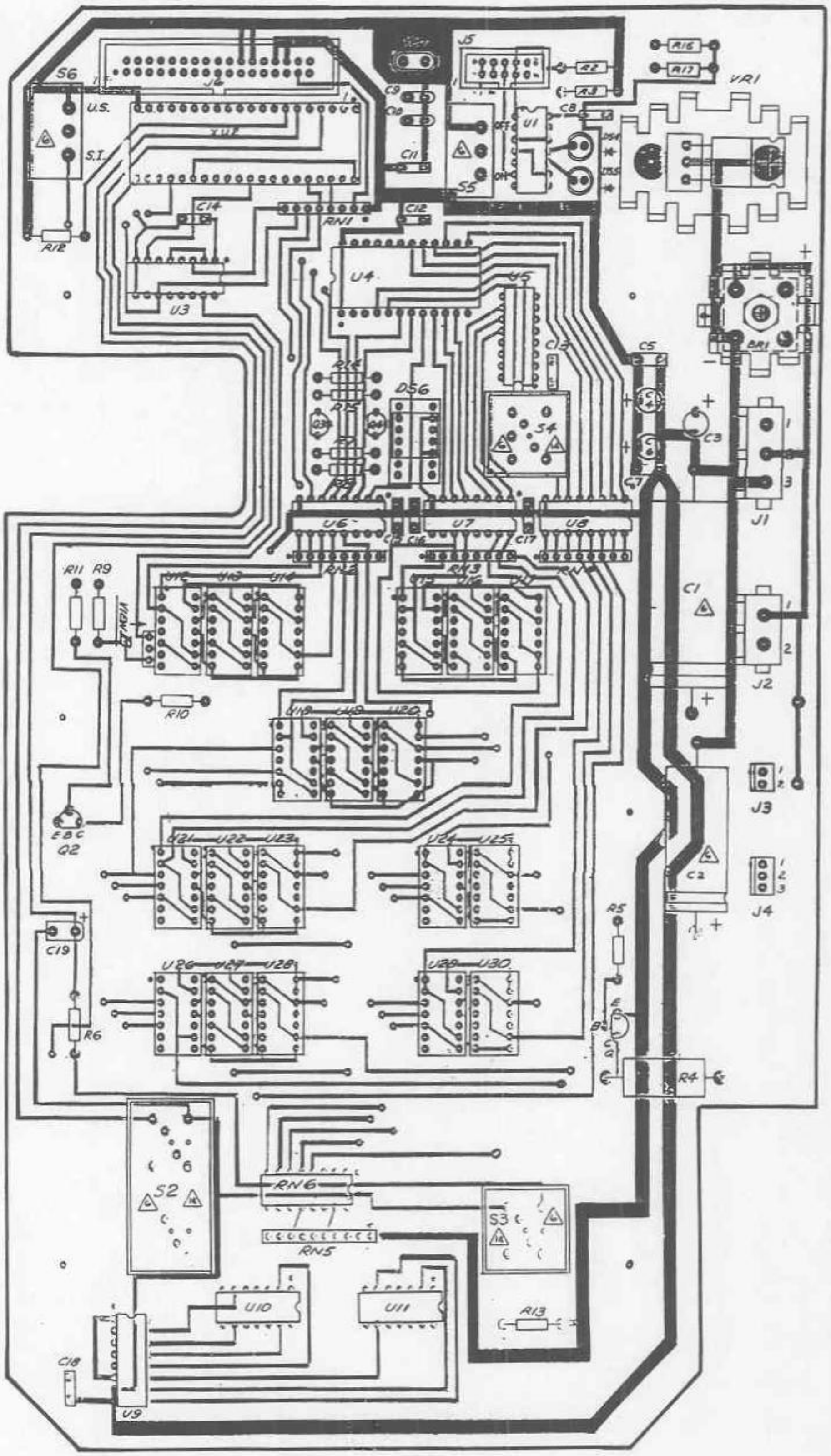
TABLE 5-7. PRINTER CIRCUIT BOARD SOCKET U1, EXPECTED VOLTAGE AND RESISTANCE VALUES (Cont)

Pin	Voltage (Volts)	Resistance (Ohms*)
26	0.02	>20M
27	0.02	>20M
28	0.02	>20M
29	0.02	>20M
30	0.02	>20M
31	0.02	>20M
32	0.02	>20M
33	0.02	>20M
34	0.62	>20M
35	0.02	>20M
36	0.02	>20M
37	0.02	>20M
38	0.02	>20M
39	0.02	>20M
40	4.88	700

* k = kilohms (X 10^3), M = megohms (X 10^6)

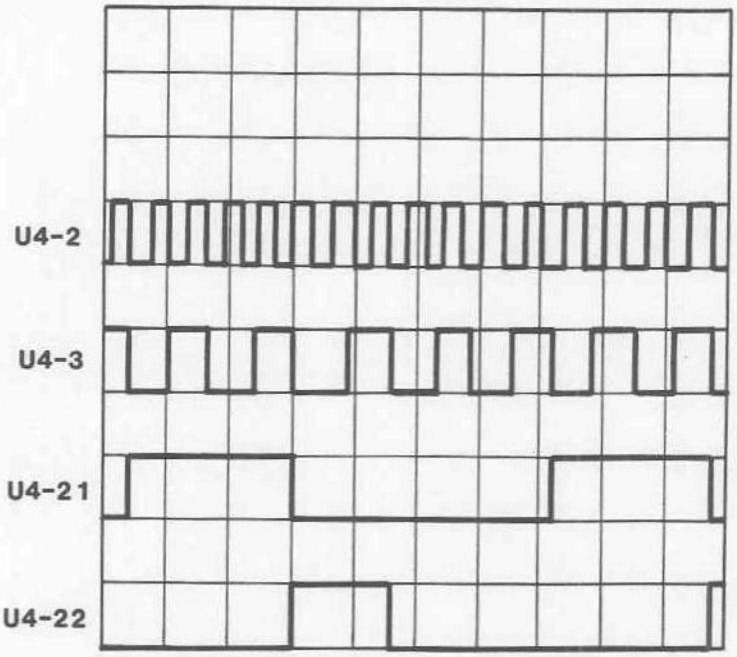
5.4.4 WAVEFORMS

Figure 5-19 identifies significant test points on the computer and printer circuit boards and waveforms to be expected at the test points.


S6
J6
U.S.
S.I.
XU2
C9
C10
C11
J5
R2
R3
C8
U1
S5
R16
R17
VR1
C14
RN1
C12
R12
U3
U4
U5
C13
C5
BR1
DS6
S4
C3
J1
U6
U7
U8
C16
C17
RN2
RN3
RN4
C1
J2
R11
R9
R10
J3
E B C
Q2
C2
J4
R5
C19
R6
R4
S2
RN6
RN5
S3
U10
U11
R13
C18
U9

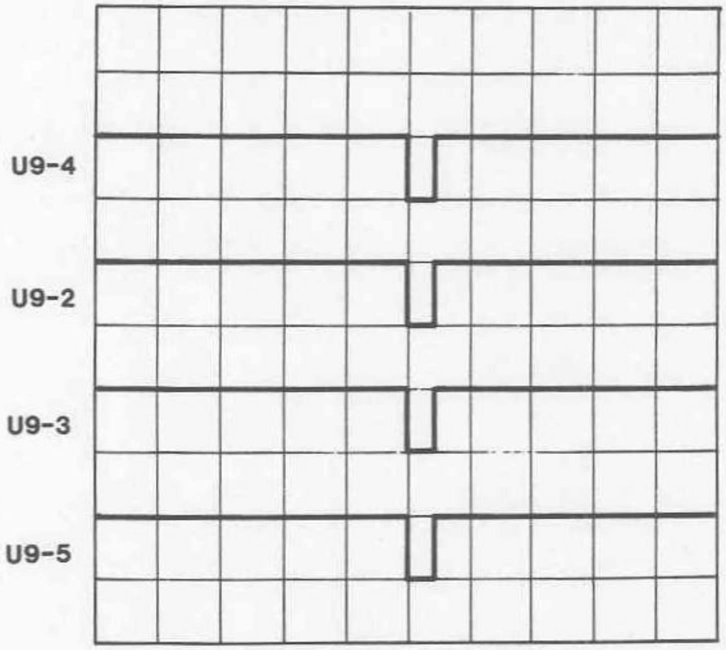
A. COMPUTER CIRCUIT BOARD

Figure 5-19. Waveform Diagram (Sh 1 of 3)



AMPLITUDE = 5V/DIVISION; TIMING = 2 mS/DIVISION

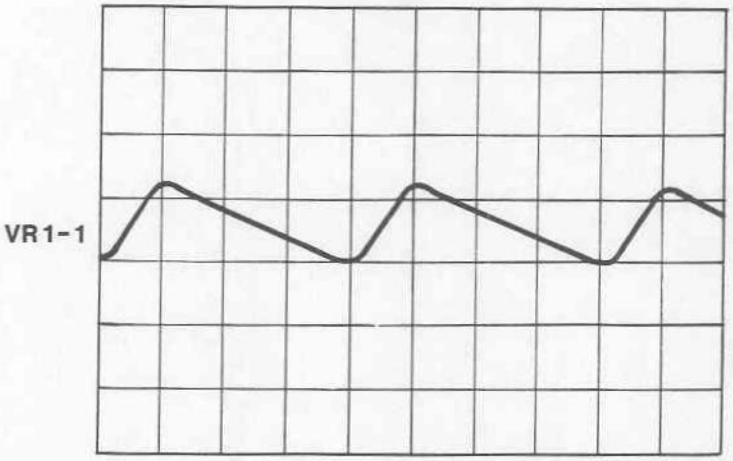
B. DISPLAY DEVICE DECODER U4
INPUT WAVEFORMS



AMPLITUDE = 5V/DIVISION; TIMING = 2 mS/DIVISION

C. DISPLAY SEGMENT DRIVER/DECODER U9
INPUT WAVEFORMS

Figure 5-19. Waveform Diagram (Sh 2 of 3)



AMPLITUDE = 0.5V/DIVISION; TIMING = 2 mS/DIVISION

D. POWER SUPPLY RIPPLE AT VR1 INPUT

NOTES:

1. WAVEFORMS SHOWN WITH READER IN IDLE CONDITION
2. DISPLAYS SHOWN BLANKED EXCEPT FOR DECIMAL POINT.

Figure 5-19. Waveform Diagram (Sh 3 of 3)

5.4.5 TROUBLESHOOTING

Problems that may be encountered with the mechanical or optical system during testing are described in Table 5-8.

Problems that may be encountered during testing with the venous or capillary calibration check tube or during general testing are described in Table 5-9.

Problems that may be encountered during self-test are described in Table 5-10. Problems that may be encountered with the power supply are described in Table 5-11. Refer to the schematic diagrams of the computer circuit board and the printer circuit board, Figures 8-1 and 8-2, respectively, in conjunction with the troubleshooting information in Tables 5-10 and 5-11.

> NOTE
>
> If corrective action is to replace either microprocessor U2 on computer circuit board or EPROM U1 on printer circuit board, replacement device must have exactly the same version as the one currently installed. If only replacement available is device with a different version, replace both U1 and U2 with devices of like version.

TABLE 5-8. TROUBLESHOOTING TABLE, TUBE ROTATION AND IMAGE PROBLEMS

	Symptom	Probable Cause	Remedy
1.	Tube rotation excessively wobbly or jumpy.	a. Drum roller or tube holder caked with dried blood or foreign matter.	a. Clean roller and holder with "Q-tip" wetted with isopropyl alcohol.
		b. Deformed or dirty thrust pivot.	b. Replace thrust pivot in accordance with Paragraph 9.19 of this manual.
2.	Tube rotation intermittent or well below nominal speed of 1350 RPM.	a. Sticky or wet tube or drum roller.	a. Wipe blood tube dry or clean drum roller with "Q-tip" wetted with isopropyl alcohol.
		b. Excessive buildup of static electricity.	b. Clean roller and tube holder with "Q-tip" wetted with isopropyl alcohol. Also check ground connection.
		c. Defective thrust pivot.	c. See 1.b.
		d. Defective motor assembly.	d. Replace motor assembly in accordance with Paragraph 9.14 of this manual.

TABLE 5-8. TROUBLESHOOTING TABLE, TUBE ROTATION AND IMAGE PROBLEMS (Cont)

NOTE

Symptoms 3 through 8 describe "through-the-scope" anomalies in visual appearance of prompt display elements and rotating blood tube, usually indicating defect in or misalignment of reader optics.

	Symptom		Probable Cause		Remedy
3.	Double image of arrow or blood tube.	a.	Beam splitter cracked.	a.	Replace beam splitter in accordance with Paragraph 9.7 of this manual.
		b.	Microscope lens or filter cracked.	b.	Replace microscope in accordance with Paragraph 9.6 of this manual.
4.	Image of blood tube present , but arrow missing.	a.	Reticle arrow lamp defective.	a.	Replace lamp in accordance with Paragraph 9.12 of this manual.
		b.	Reticle arrow assembly grossly out of alignment.	b.	Realign reticle arrow in accordance with Paragraph 5.4.1.1 of this manual.
		c.	Beam splitter broken off.	c.	See 3.a.
5.	Second or dark red-to-light red interface at bottom of float very difficult to read. visible (not backlighted).	a.	Tube lamp (white light) defective	a.	Replace lamp in accordance with Paragraph 9.11 of this manual.
		b.	Incorrect lamp alignment.	b.	Align tube lamp in accordance with Paragraph 5.4.1.5 of this manual.
		c.	Computer circuit board defective.	c.	Replace circuit board in accordance with Paragraph 9.3 of this manual.
6.	Blood tube and arrow appear to move in relation to each other when viewed at different positions around eyepiece.	a.	Parallax error due to misalignment of reticle arrow assembly.	a.	Realign reticle arrow in accordance with Paragraph 5.4.1.3 of this manual.
		b.	See Probable Cause column in Table 5-9.	b.	See Remedy column in Table 5-9.
7.	Tube does not fluoresce, or fluorescing area is not symmetrical around reticle arrow.		Illuminator lamp tilted in lamp socket, or entire illuminator lamp assembly needs realignment.		Check that lamp is seated straight in socket. To realign lamp assembly, refer to procedure in Paragraph 5.4.1.4
8.	Tip of reticle arrow overlaps or is too far away from blood tube, interfering with reading of cell interfaces.		Reticle arrow assembly is out of alignment.		See Remedy for Symptom 6.

TABLE 5-9. TROUBLESHOOTING TABLE, CALIBRATION CHECK AND TEST INACCURACIES

	Symptom	Probable Cause	Remedy
1.	One or more values from calibration check tube reading are out of tolerance.	a. Calibration tube read in wrong mode.	a. Recheck for correct mode, i.e., VEN or CAP, then read again.
		b. Parallax error due to misalignment of reticle arrow.	b. Recheck focus for sharp, clear image; then move eye around circumpherence of eyepiece and observe whether arrow and tube move independently of each other. If arrow and tube do not stay together, realign reticle arrow assembly in accordance with Paragraph 5.4.1.3 of this manual.
		c. Defective calibration tube.	c. Test different calibration tube.
		d. Optical encoder defective.	d. Check optical encoder in accordance with Paragraph 5.3.4.2 of this manual.
		e. Computer circuit board defective.	e. Replace circuit board in accordance with Paragraph 9.3 of this manual.
2.	QBC test value(s) not correlated with reference values.	a. Blood tube prepared longer than specified time after collection.	a. For full panel test (HCT, WBC, PLT), prepare tube within 90 minutes of collection. For HCT and WBC only, prepare tube within 4 hours of collection.
		b. Ambient laboratory temperature below 20°C (68°F). (Note that low temperature may result in erroneously high test values.)	b. Raise temperature of laboratory or relocate system to an acceptable area.
		c. In venous-blood test, specimen collected into or treated with unapproved anticoagulant such as heparin, citrate, or oxalate.	c. Use VACUTAINER's or blood collection syringes anticoagulated only with Na_2- or K_3-EDTA.
		d. In venous-blood test, specimen not well mixed prior to filling QBC tube.	d. Prepare new tube from well-mixed specimen.

TABLE 5-9. TROUBLESHOOTING TABLE, CALIBRATION CHECK AND TEST INACCURACIES (Cont)

	Symptom	Probable Cause	Remedy
2.	(Cont)	e. Centrifuge speed too high or spin cycle too long (>5-1/2 minutes), causing erroneously low QBC values. (Non-optimum cell packing.)	e. Check centrifuge speed and timer accuracy in accordance with centrifuge Maintenance Manual.
		f. Centrifuge speed too low or spin cycle too short (<4-1/2 minutes), causing erroneously high QBC values. (Non-optimum cell packing.)	e. See 2.e.
		g. Lamp segment(s) in display device defective, causing display of false character (e.g., "4" instead of "9").	g. Verify by pressing CLEAR and checking for display of "8" in every character position. If all segments do not light, refer to Table 5-10.
		h. In venous-blood test, EDTA-containing blood collection tube not filled with specimen to at least 2/3 of its volume (least likely cause).	h. Ensure that anticoagulant-containing collection tube is filled with blood to at least 2/3 of its fill volume.

TABLE 5-10. TROUBLESHOOTING TABLE, ELECTRONIC CIRCUITS

	Symptom	Probable Cause	Remedy
1.	Segment inoperative on one display device, all other devices normal.	Display device segment defective.	Replace display device.
2.	Same segment inoperative on all display devices.	Transistor array or decoder U9 defective.	If segment a, b, c, or d.p., replace U11. If segment d, e, f, or g, replace U10. Replace U9.
3.	All segments inoperative on all display devices, d.p. normal only on U13.	Decoder U9 defective.	Replace U9.
4.	One display device inoperative, all other devices normal.	Display device cathode defective.	Replace display device.
5.	All or either of HCT and WBC displays inoperative, all other displays normal.	Driver U6 defective.	Replace driver.

TABLE 5-10. TROUBLESHOOTING TABLE, ELECTRONIC CIRCUITS (Cont)

	Symptom	Probable Cause	Remedy
6.	All or one of PLT and GRANS (10^9/L) displays inoperative, all other displays normal.	Driver U7 defective.	Replace driver.
7.	All or one of %GRANS, LYMPH/MONO (10^9/L), and %LYMPH/MONO displays inoperative, all other displays normal.	Driver U8 defective.	Replace driver.
8.	All or one of GRANS (10^9/L) display devices inoperative, all other displays normal.	a. Decoder U5 defective.	a. Replace decoder.
		b. Inverter U3 (pins 6, 7) defective.	b. Replace inverter.
9.	All displays except GRANS (10^9/L) inoperative.	Decoder U4 defective.	Replace decoder.
10.	All displays inoperative.	Microprocessor U2 defective.	Replace microprocessor.
11.	HCT decimal point operation abnormal, all other display functions normal.	Transistor Q2 defective.	Replace transistor.
12.	CAP LED not lighted with VEN/CAP switch in CAP position.	a. CAP LED DS6(b,c) defective.	a. Replace LED.
		b. Transistor Q3 or inverter U3 defective.	b. Check components and replace if defective.
		c. Switch S4 defective.	c. Replace switch.
13.	VEN LED not lighted with VEN/CAP switch in VEN position.	a. VEN LED DS6(a-d) defective.	a. Replace LED.
		b. Transistor Q4 defective.	b. Replace transistor.
		c. Switch S4 defective.	c. Replace switch.
14.	Enter function abnormal.	a. ENTER switch S2 defective.	a. Replace switch.
		b. Microprocessor U2 defective.	b. Momentarily ground pin 1 of ENTER switch. If enter function not initiated replace microprocessor.
15.	Clear function abnormal.	a. CLEAR switch S3 defective.	a. Replace switch.
		b. Microprocessor U2 defective.	b. Momentarily ground pin 2 of CLEAR switch. If reset function not initiated, replace microprocessor.
		c. Capacitor C19 defective.	c. Check capacitor for short; replace if necessary.

TABLE 5-10. TROUBLESHOOTING TABLE, ELECTRONIC CIRCUITS (Cont)

	Symptom	Probable Cause	Remedy
16.	Tube lamp (white light) inoperative.	a. Tube lamp DS3 defective.	a. Replace lamp.
		b. Transistor Q1 defective.	b. Replace transistor.
17.	Encoder channel A abnormal, channel B normal.	a. If input to U2 normal, DS4 LED circuit defective.	a. Check DS4 LED and NAND gate U1 (pin 12/13, 11), and replace if defective.
		b. If input to U2 and DS4 LED operation abnormal, NAND gate U1 (pins 1-3) defective.	b. Replace NAND gate.
18.	Encoder channel B abnormal, channel A normal.	a. If input to U2 normal, DS5 LED circuit defective.	a. Check DS5 LED and NAND gate U1 (pin 8/9, 10), and replace if defective.
		b. If input to U2 and DS5 LED abnormal, NAND gate U1 (pins 4-6) defective.	b. Replace NAND gate.
19.	Encoder channels A and B abnormal.	Encoder defective.	Replace encoder in accordance with Paragraph 9.23 of this manual.
20.	Microprocessor U2 operation erratic.	Crystal XC1 defective.	Replace crystal.
21.	P1 error flag displayed during self-test sequence.	Microprocessor U2 failed RAM test.	Replace microprocessor.
22.	P2 error flag displayed during self-test sequence.	Microprocessor U2 on computer circuit board or EPROM U1 on printer circuit board failed ROM test.	Replace microprocessor and EPROM, one at a time, making sure that versions of both devices match.

TABLE 5-11. TROUBLESHOOTING TABLE, POWER SUPPLY

	Symptom	Probable Cause	Remedy
1.	No output of +5 VDC, +10 VDC output normal.	Voltage regulator VR1 defective.	Replace voltage regulator.
2.	No output of +5 VDC or +10 VDC.	Bridge rectifier BR1 defective.	Replace bridge rectifier.
3.	Illuminator (blue) lamp not lighted, reticle (arrow) lamp normal, transformer output normal.	Illuminator lamp DS1 defective.	Replace lamp.
4.	Reticle (arrow) lamp not lighted, illuminator (blue) lamp normal.	Reticle lamp DS2 defective.	Replace lamp.

TABLE 5-11. TROUBLESHOOTING TABLE, POWER SUPPLY (Cont)

	Symptom	Probable Cause	Remedy
5.	Neither illuminator lamp nor reticle lamp lighted, fan and rotator operate.	Transformer T1 defective.	Replace transformer.
6.	Rotator motor inoperative, fan motor operative.	Rotator motor defective.	Replace motor.
7.	Fan motor inoperative, rotator motor operative.	Fan motor defective.	Replace motor.
8.	Illuminator and reticle lamps, fan, rotator, and neon lamp in POWER switch inoperative.	a. Fuse F1 blown.	a. Replace fuse.
		b. POWER switch S1 or interlock switch S2 defective.	b. Check switches and replace defective component.

SECTION 6. STORAGE

6.1 INDOOR STORAGE

Prepare the reader for indoor storage as follows:

- a. Locate shipping materials, reserved when reader first was installed.
- b. Identify shipping cylinder and shipping cap for microscope (Figure 2-1), and reinstall them on microscope.
- c. Place reader in plastic bag, seal bag with tape, and return all parts to their original shipping carton as shown in Figure 2-1.

Specialized heating or cooling equipment is not required, provided the environmental conditions in the storage area do not exceed the following limits:

Temperature: -26° to 55°C (-15° to 131°F)

Relative Humidity: 10% to 95%, non-condensing

External packaging containers should be inspected visually on a routine basis. Inspection of internal components is not required.

If the reader has been in storage for 2 years or more and is to be placed into operation, all components should be referred to a qualified serviced technician for inspection and performance evaluation before using them to test blood for medical purposes. Particular attention should be paid to functional testing of the QBC Pipetter after storage for 2 years or more.

After 3 years of storage, the venous and capillary calibration check tubes must be inspected visually for air bubbles.

After 5 years of storage, various internal components of the reader must be checked visually by the service technician as part of a complete pre-operational inspection and performance evaluation.

6.2 OUTDOOR STORAGE

The QBC_{II} Reader is not recommended for outdoor storage unless the environmental conditions specified in Paragraph 6.1 can be maintained and the complete system has been packaged in a waterproof container. Refer the reader to a qualified service technician if the container shows evidence of exposure to water or moisture.

SECTION 7. PARTS LIST

This section identifies replacement parts on the QBC_{II} Reader and the Pipetter.

The left column of parts lists that are primarily mechanical refers to the illustration on which the part is shown (i.e., 1- or 4- refers to Figure 1 or Figure 4). The exact location of the part on the illustration is identified by an index number on the referenced illustration (e.g., -6). The full identification of the part location for the example given, therefore, would be "1-6" or "4-6."

The left column of parts lists that are primarily electrical refers to the illustration on which the part is shown (i.e., 2- or 3- refers to Figure 2 or Figure 3). The exact location of the part on the illustration is identified by the reference designation of the part, which is silk-screened on the circuit board (e.g., -R1). The full identification of the part locations for the examples given, therefore, would be "2-R1" or "3-R1."

The "Reorder No." column identifies the number that should be used to order a replacement part from Becton Dickinson. The "Engineering Part No." column contains the internal number used by Becton Dickinson to identify the part. The Engineering Part No. should be used only when there is no Reorder No. specified.

The "Description" column provides a brief listing of what the part is and how it may be distinguished from another part with a similar name. The numbers at the top of the column (1 2 3 4 5) are used to designate generation levels for mechanical items, "1" being the highest level. The description of each item is indented to show the degree of subordination to the assembly being broken down. Dots are used to fill the spaces for the higher level(s). Item 1-20 (Carriage Assy), for example, is identified by two dots to show that it is part of Item 1-19 (Frame and Mechanism Assy, the next prior one dot). On the other hand, the first item of breakdown for 1-20 (two dots) is 1-21 (three dots, the Pivot Assy).

The "Quantity per Assembly" column identifies the total quantity used for of that part. Where a part is shown on more than one illustration, the quantity is given only for the first listing of the part; subsequent listings contain "REF" (reference) as the quantity.

Figure & Index No.	Reorder No.	Engineering Part No.	Description	Quantity per Assembly
			1 2 3 4 5	
1-	Model 4477	---	QBC$_{II}$ READER	
-1	4326-601-028	4326-001-028	. HOUSING, lower	1
-2		4326-001-033	. . INSERT, knob	1
-3		4326-001-032	. . COVER, rear	1
-4	4460-650-024	4460-050-024	. FOOT	4
-5	4326-601-034	4326-001-034	. HOUSING, upper	1
-6	4460-650-010	4460-050-010	. PANEL, display	1
-7	4460-650-014	4460-050-014	. GASKET, panel	1
-8	4460-650-013	4460-050-013	. KNOB, crank	1
-9	4460-639-000	4460-039-000	. MICROSCOPE ASSY	1
-10	4460-650-022	4460-050-022	. COLLAR, microscope	1
-11	4460-626-000	4460-026-000	. CORDSET ASSY	1
-12	2510-624-328	4460-052-000	. SWITCH, interlock (S2)	1
-13	4460-650-015	4460-050-015	. SHIELD	1
-14	2510-623-814	2510-423-814	. FUSE, 1-1/2 amp, Slo-Blo, (F1) (Littlefuse 3AG-4A-313)	1
-15	4461-650-006	4461-050-006	. INSULATOR, heat	1
-16	4463-603-000	4463-003-000	. CABLE, ribbon, P6 to P7	1
-17	4460-616-007	4460-016-007	. BLOCK, microscope	1
-18	4460-612-000	4460-012-000	. CLAMP AND CUSHION, microscope	1
-19	4477-610-000	4477-210-000	. FRAME AND MECHANISM ASSY	1
-20	4326-632-000	4326-032-000	. . CARRIAGE ASSY	1
-21	4460-602-001	---	. . . PIVOT ASSY, thrust, set	1
	---	4460-050-030	. . . . PIVOT, barbed	1
	---	4460-050-032	. . . . SOCKET, inner (adapter)	1
	---	4460-050-031	. . . . SOCKET, outer (adapter)	1
-22	4477-630-000	4477-230-000	. . MOTOR AND HARNESS ASSY	1
-23	4326-630-001	4326-030-001	. . PLATE, mounting	1
-24	4200-629-009	4200-229-009	. . UNIVERSAL JOINT	1
-25	4326-631-000	4326-031-000	. . SHAFT, rotator	1
-26	4326-630-003	4326-030-003	. . DRUM, rotator	1
-27	4326-633-001	4326-033-001	. . SCREW, lead	1
-28	4460-617-008	4460-017-008	. . GEAR, miter, set	1
-29	4460-635-000	4460-054-000	. . ENCODER, optical	1
-30	4200-603-008	4200-003-008	. FILTER, FITC	1
-31	4460-603-004	4460-103-004	. LENS, illuminator	1
-32	4227-602-000	4227-002-000	. LAMP, illuminator, blue light (DS1)	1
-33	2510-624-512	2510-424-512	. LAMP, tube, white light (DS3)	1
-34	4460-628-000	4460-028-000	. LIGHT ASSY, white	1
-35	4460-650-002	4460-050-002	. SWITCH, power (S1)	1
-36	4463-605-000	4460-005-000	. CABLE,ribbon, P9 to P10	1
-37	4460-623-000	4460-023-000	. SOCKET ASSY, reticle lamp	1
-38	2510-624-513	2510-424-513	. LAMP, reticle, arrow (DS2)	1
-39	4460-605-000	---	. FILM AND DIFFUSER, reticle	1
-40	4460-625-000	4460-025-000	. SOCKET ASSY, illluminator lamp	1
-41	4460-616-004	4460-016-004	. BEAM SPLITTER	1
-42	4477-511-000	4477-511-000	. BOARD ASSEMBLY, printed circuit, printer	1
-43	4477-510-000	4477-510-000	. BOARD ASSY, printed circuit, computer	1
-44	2510-621-746	2510-421-746	. DISPLAY, 7 segment and decimal point	19
-45	2510-624-519	2510-424-519	. DIODE, light emitting, light bar, green	1
-46	4477-600-003	4477-100-003	. FAN	1
-47	4477-600-005	4477-100-005	. GASKET, fan	1
-48	4477-600-004	4477-100-004	. BRACKET, fan	1
-49	4460-627-000	4460-027-000	. TRANSFORMER (T1)	1
-50	4406-650-005	4406-050-005	. STANDOFF, panel	2
-51	4460-600-012	4460-100-012	. STANDOFF, panel	4
-52	4460-650-016	4460-050-016	. STANDOFF, computer board	6

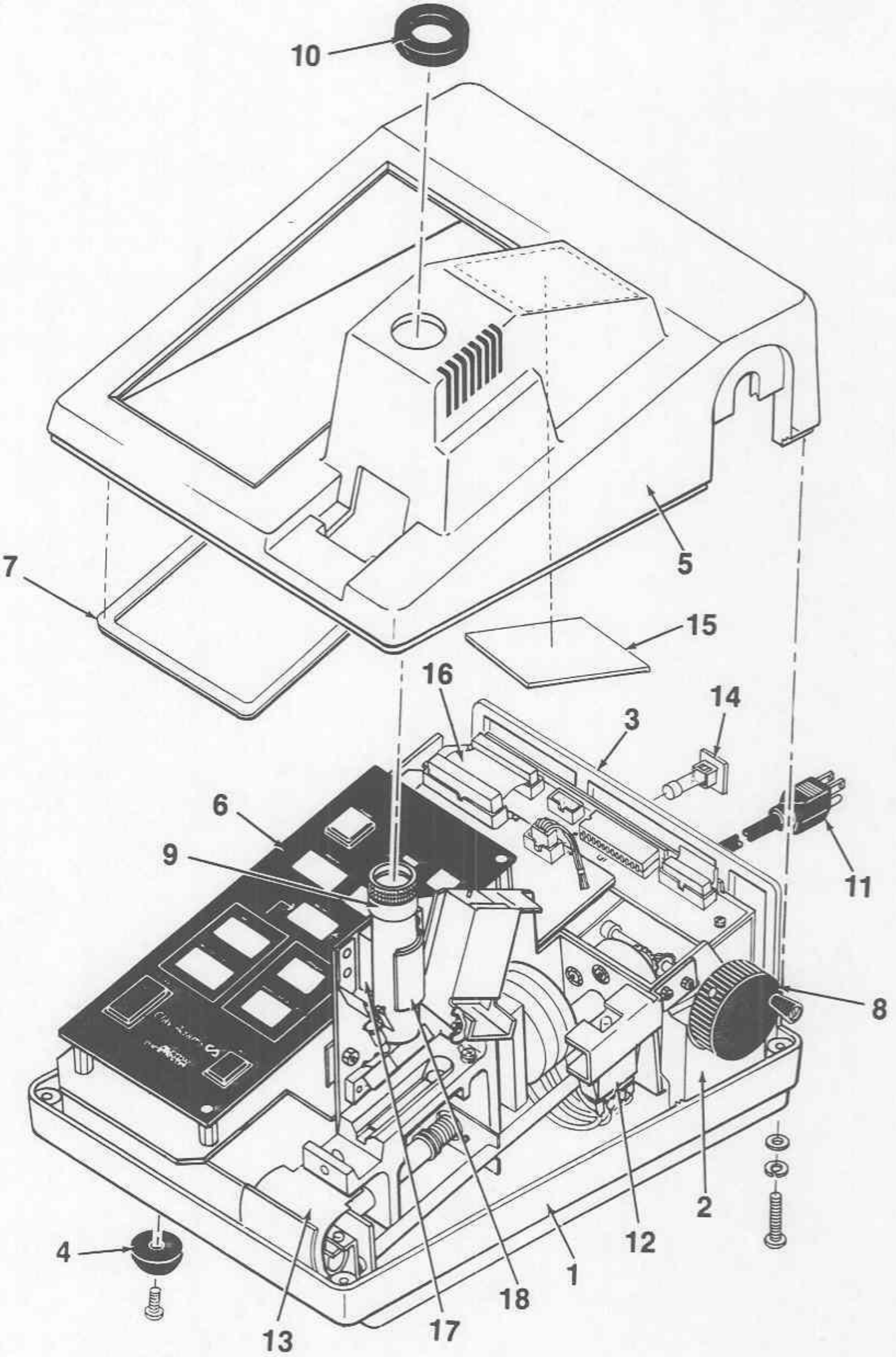

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Figure 1. QBC$_{II}$ Reader
(Sh 1 of 4)

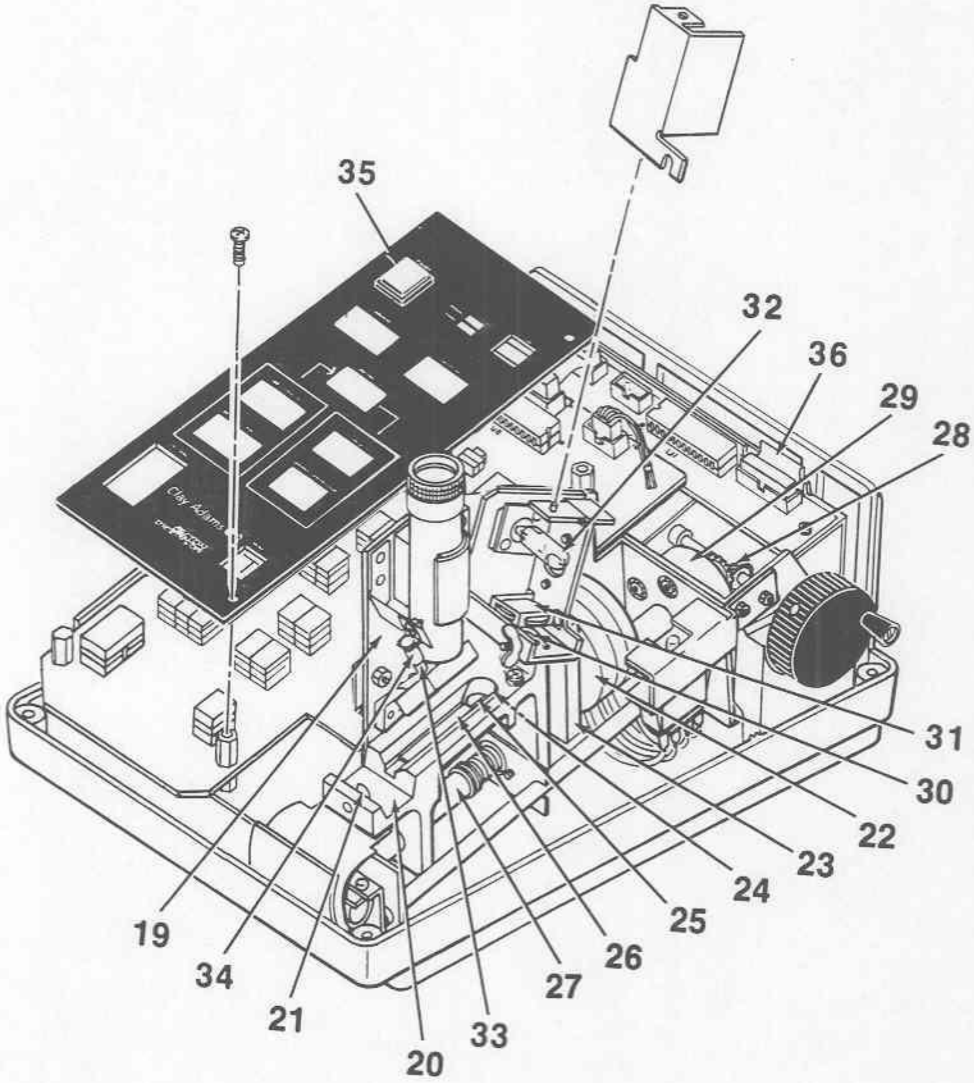
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Figure 1. QBC_{II} Reader
(Sh 2 of 4)

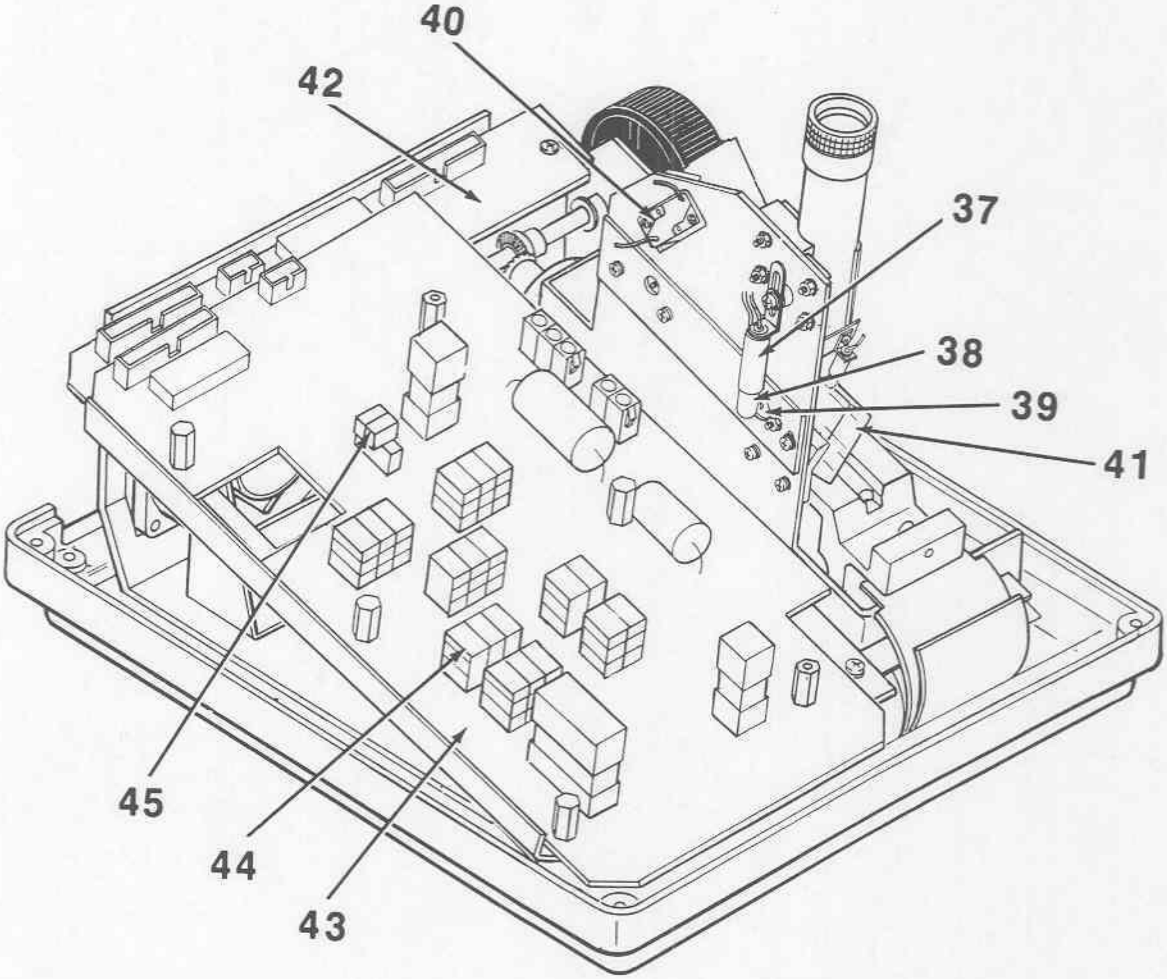
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Figure 1. QBC_{II} Reader
(Sh 3 of 4)

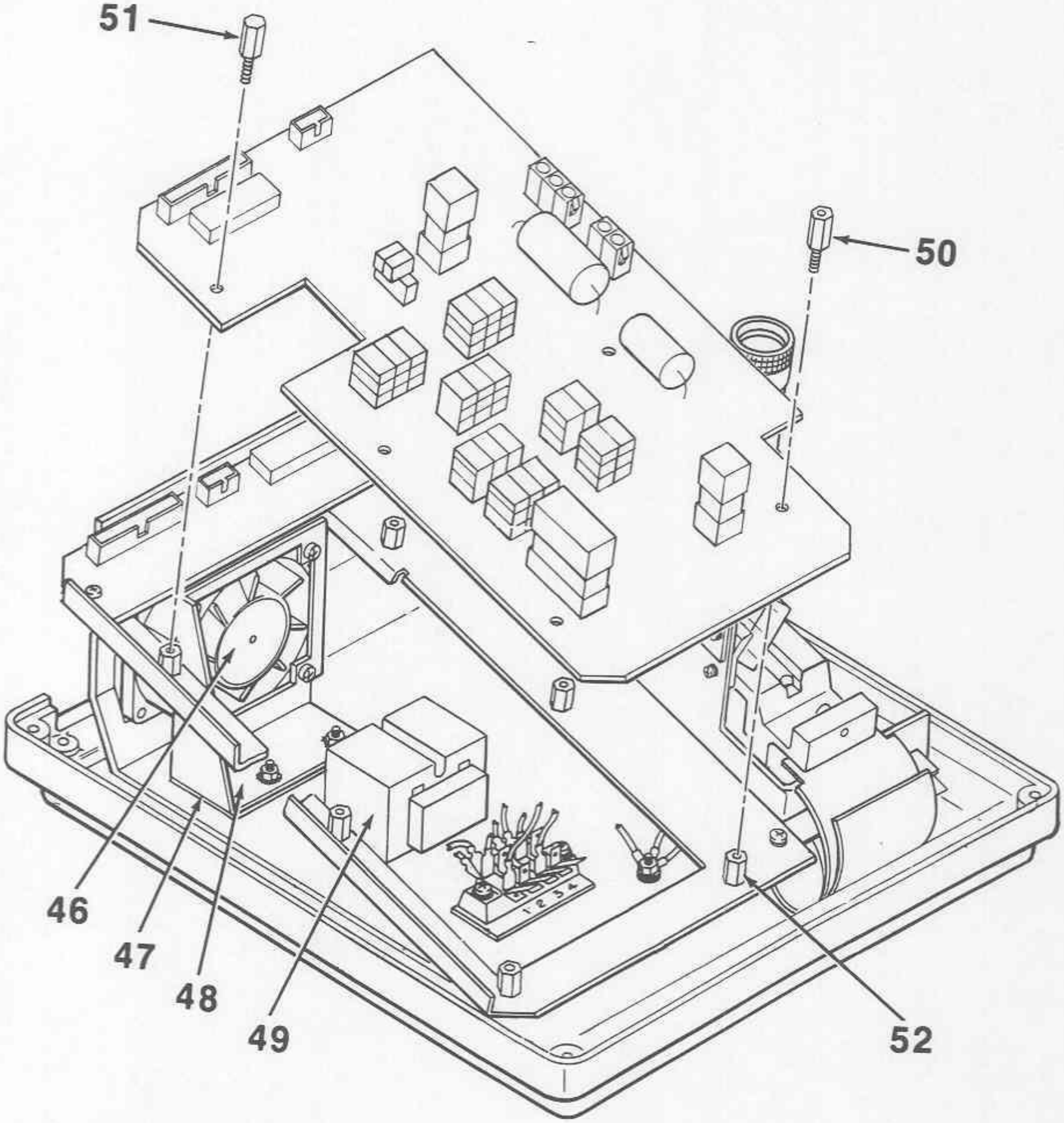
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Figure 1. QBC_{II} Reader
(Sh 4 of 4)

Figure & Ref. Desig.	Reorder No.	Engineering Part No.	Description 1 2 3 4 5	Quantity per Assembly
2-	4457-510-000	4457-510-000	BOARD ASSY, printed circuit, computer (see Fig.1)	REF
-BR1	2510-623-133	2510-423-133	BRIDGE RECTIFIER	1
- 2	2510-623-240	2510-423-240	. HEATSINK: for BR1	2
-C1	2510-620-278	2510-420-278	CAPACITOR, electrolytic, 2200 UF, 35 WVDC, radial leads	1
-C2	2510-620-279	2510-420-279	CAPACITOR, electrolytic, 1000 UF, 35W VDC, radial leads	1
-C3	2510-620-043	2510-420-043	CAPACITOR, tantalum, 10 UF ±10%, 25 WVDC	1
-C4	2510-620-005	2510-420-005	CAPACITOR, tantalum, 1 UF ±10%, 35 WVDC	2
-C5	2510-619-510	2510-419-510	CAPACITOR, ceramic, 0.1 UF ±20%, 100 WVDC	6
-C6	2510-620-005	2510-420-005	CAPACITOR, tantalum, same as C4	REF
-C7	2510-619-510	2510-419-510	CAPACITOR, same as C5	REF
-C8	2510-619-255	2510-419-255	CAPACITOR, ceramic, 0.01 UF ±10%, 100 WVDC	5
-C9	2510-618-010	2510-418-010	CAPACITOR, mica, 20 pF ±10%, 500 WVDC	1
-C10	2510-618-014	2510-418-014	CAPACITOR, mica, 5 pF ±10%, 500 WVDC	1
-C11	2510-619-255	2510-419-255	CAPACITOR, ceramic, same as C8	REF
-C12	2510-619-255	2510-419-255	CAPACITOR, ceramic, same as C8	REF
-C13	2510-619-255	2510-419-255	CAPACITOR, ceramic, same as C8	REF
-C14	2510-619-255	2510-419-255	CAPACITOR, ceramic, same as C8	REF
-C15	2510-619-510	2510-419-510	CAPACITOR, ceramic, same as C5	REF
-C16	2510-619-510	2510-419-510	CAPACITOR, ceramic, same as C5	REF
-C17	2510-619-510	2510-419-510	CAPACITOR, ceramic, same as C5	REF
-C18	2510-619-510	2510-419-510	CAPACITOR, ceramic, same as C5	REF
-C19	2510-620-024	2510-420-024	CAPACITOR, tantalum, 3.3 UF ±10%, 35 WVDC	1
-DS1			Not used	
-DS2			Not used	
-DS3		Not used		
-DS4	2510-624-518	2510-424-518	DIODE, light emitting	2
-DS5	2510-624-518	2510-424-518	DIODE, light emitting, same as DS4	REF
-DS6	2510-624-519	2510-424-519	DIODE, light emitting, light bar, green (see Fig. 1, Sh 3)	REF
-J1	2510-624-109	2510-424-109	CONNECTOR, 3-pin header	1
-J2	2510-624-211	2510-424-211	CONNECTOR, 2-pin header	1
-J3	2510-624-044	2510-424-044	CONNECTOR, 2-pin header	1
-J4	2510-624-032	2510-424-032	CONNECTOR, 3-pin header	1
-J5	2510-624-222	2510-424-222	CONNECTOR, 10-pin header	1
-J6	2510-624-246	2510-424-246	CONNECTOR, 34-pin header	1
-Q1	2510-621-111	2510-421-111	TRANSISTOR, MPS A14	1
- 3	2510-623-004	2510-423-004	SPREADER, mounting pad	4
-Q2	2510-621-103	2510-421-103	TRANSISTOR, 2N3906	3
- 3		2510-423-004	SPREADER	REF

Figure & Ref. Desig.	Reorder No.	Engineering Part No.	Description	Quantity per Assembly
			1 2 3 4 5	
2-			Cont	
-Q3	2510-621-103	2510-421-103	TRANSISTOR, same as Q2	REF
- 3		2510-423-004	SPREADER	REF
-Q4	2510-621-103	2510-421-103	TRANSISTOR, same as Q2	REF
- 3		2510-423-004	SPREADER	REF
-R1			Not used	
-R2	2510-605-114	2510-405-114	RESISTOR, 51 kilohms ±5%, 1/4 W	2
-R3	2510-605-114	2510-405-114	RESISTOR, same as R2	REF
-R4	2510-616-007	2510-416-007	RESISTOR, 24 ohms ±5%, 0.2 W	1
-R5	2510-605-083	2510-405-083	RESISTOR, 2.7 kilohms ±5%, 1/4 W	1
-R6	2510-605-073	2510-405-073	RESISTOR, 1 kilohm ±5%, 1/4 W	4
-R7	2510-605-049	2510-405-049	RESISTOR, 100 ohms ±5%, 1/4 W	3
-R8	2510-605-049	2510-405-049	RESISTOR, same as R7	REF
-R9	2510-605-049	2510-405-049	RESISTOR, same as R7	REF
-R10	2510-605-033	2510-405-033	RESISTOR, 22 ohms ±5%, 1/4 W	1
-R11	2510-605-097	2510-405-097	RESISTOR, 10 kilohms ±5%, 1/4 W	2
-R12	2510-605-073	2510-405-073	RESISTOR, same as R6	REF
-R13	2510-605-097	2510-405-097	RESISTOR, same as R11	REF
-R14	2510-605-073	2510-405-073	RESISTOR, same as R6	REF
-R15	2510-605-073	2510-405-073	RESISTOR, same as R6	REF
-R16	2510-605-061	2510-405-061	RESISTOR, 330 ohms ±5%, 1/4 W	2
-R17	2510-605-061	2510-405-061	RESISTOR, same as R16	REF
-RN1	2510-616-534	2510-416-534	RESISTOR NETWORK, SIP-8, 5.6 kilohms ±2%, 0.2 W	1
-RN2	2510-616-514	2510-416-514	RESISTOR NETWORK, SIP-8, 10 kilohms ±2%, 0.2 W	3
-RN3	2510-616-514	2510-416-514	RESISTOR NETWORK, same as RN2	
-RN4	2510-616-514	2510-416-514	RESISTOR NETWORK, same as RN2	REF
-RN5	2510-616-506	2510-416-506	RESISTOR NETWORK, SIP-10, 10 kilohms ±2%, 0.2 W	1
-RN6	2510-616-503	2510-416-503	RESISTOR NETWORK, DIP-16, 22 ohms ±2%, 0.2 W	1
-S1			Not used	
-S2	2510-625-333	2510-425-333	SWITCH, pushbutton, momentary contact, dual	1
- 4	4460-613-007	4460-013-007	FILM INSERT, switch, rectangular, black	1
- 5	2510-625-337	2510-425-337	LENS CAP, double, w/diffuser	1
-S3	2510-625-334	2510-425-334	SWITCH, pushbutton, momentary contact, N.O.	1
- 6	4460-613-006	4460-013-006	FILM INSERT, switch, square, black	2
- 7	2510-625-336	2510-425-336	LENS CAP, single, w/diffuser	2
-S4	2510-625-343	2510-425-343	SWITCH, pushbutton, maintained contact	1
- 6	4460-613-006	4460-013-006	FILM INSERT, see S3	REF
- 7	2510-625-336	2510-425-336	LENS CAP, see S3	REF
-S5	2510-625-332	2510-425-332	SWITCH, slide, spdt	2
-S6	2510-625-332	2510-425-332	SWITCH, same as S5	REF
-U1	2510-621-591	2510-421-591	INTEGRATED CIRCUIT, quad NAND trigger	1
-U2	4277-611-001	4477-411-001	INTEGRATED CIRCUIT, microprocessor	1

Figure & Ref. Desig.	Reorder No.	Engineering Part No.	Description 1 2 3 4 5	Quantity per Assembly
2-			(Cont)	
-U3	2510-621-576	2510-421-576	INTEGRATED CIRCUIT, hex buffer	1
-U4	2510-621-589	2510-421-589	INTEGRATED CIRCUIT, decoder	1
-U5	2510-621-745	2510-421-745	INTEGRATED CIRCUIT, decoder/demultiplexer	1
-U6	2510-621-592	2510-421-592	INTEGRATED CIRCUIT, driver array	3
-U7	2510-621-592	2510-421-592	INTEGRATED CIRCUIT, same as U6	REF
-U8	2510-621-592	2510-421-592	INTEGRATED CIRCUIT, same as U6	REF
-U9	2510-621-594	2510-421-594	INTEGRATED CIRCUIT, display driver	1
-U10	2510-621-113	2510-421-113	INTEGRATED CIRCUIT, quad transistor array	2
-U11	2510-621-113	2510-421-113	INTEGRATED CIRCUIT, same as U10	REF
-U12	2510-621-746	2510-421-746	DISPLAY, 7 segment and d.p.(see Fig. 1, Sh 3)	REF
-U13	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U14	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U15	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U16	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U17	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U18	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U19	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U20	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U21	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U22	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U23	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U24	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U25	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U26	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U27	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U28	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U29	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-U30	2510-621-746	2510-421-746	DISPLAY, same as U12	REF
-VR1	2510-621-581	2510-421-581	REGULATOR, voltage	1
- 1	2510-623-202	2510-423-202	. HEATSINK, for VR1	1
-XC1	2510-624-815	2510-424-815	CRYSTAL, 6 megahertz	1
-XDS6	2510-623-218	2510-423-218	SOCKET, elevator, 14 pins, DIP	1
-XDS7	2510-623-217	2510-423-217	SOCKET, elevator, 3 pos, SIP	1 1
-XU2	2510-623-232	2510-423-232	SOCKET, 40 pins, DIP	1
-XU12	2510-623-200	2510-423-200	SOCKET, elevator, 14 pins	DIP19
-XU13	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU14	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU15	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU16	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU17	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU18	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU19	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU20	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF

Figure & Ref. Desig.	Reorder No.	Engineering Part No.	Description 1 2 3 4 5	Quantity per Assembly
2-			(Cont)	
-XU21	2510-623-200	2510-423-200 XU12	SOCKET, elevator, same as	REF
XU22	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU23	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU24	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU25	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU26	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU27	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU28	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU29	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF
-XU30	2510-623-200	2510-423-200	SOCKET, elevator, same as XU12	REF

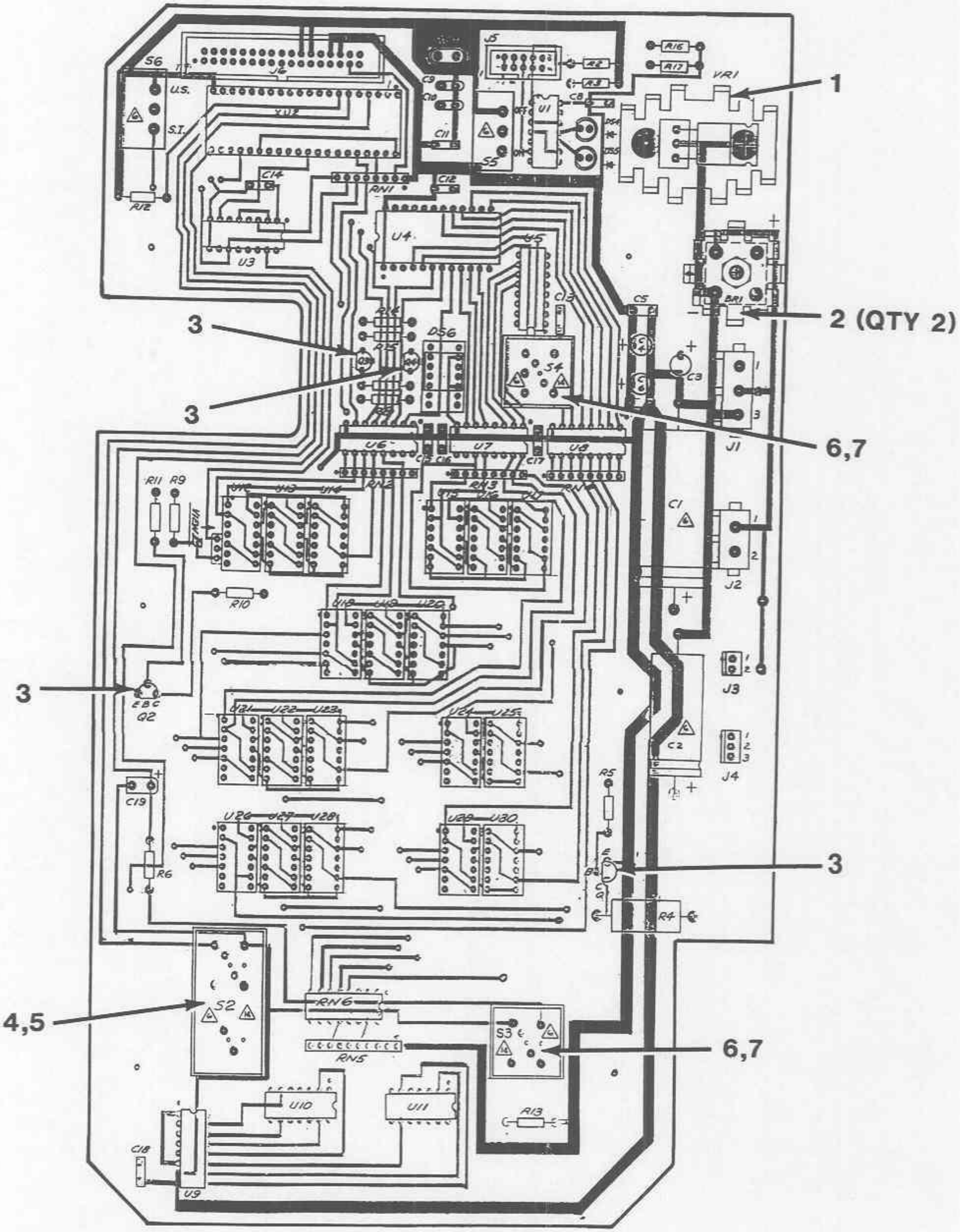

1
2 (QTY 2)
3
3
6,7
3
3
4,5
6,7
S6
U.S.
S.I.
J6
XU2
J5
R2
R3
R16
R17
VR1
C9
C10
C11
C8
U1
S5
C14
RN1
C12
U3
U4
U5
R12
BR1
C5
C13
C4
C6
C3
S4
DS6
R14
R15
J1
U6
U7
U8
C15
C16
C17
RN2
RN3
RN4
R11
R9
U12
U13
U14
U15
U16
U17
C1
J2
R10
U18
U19
U20
J3
E B C
Q2
U21
U22
U23
U24
U25
C2
J4
R5
C19
U26
U27
U28
U29
U30
R6
R4
S2
RN6
RN5
S3
R13
U10
U11
C18
U9

Figure 2. Computer Circuit Board

Figure & Ref. Desig.	Reorder No.	Engineering Part No.	Description 1 2 3 4 5	Quantity per Assembly
3-	4477-511-000	4477-511-000	BOARD ASSY, printed circuit, printer	REF
-C1	2510-619-510	2510-419-510	CAPACITOR, ceramic, 0.1 UF ±20%, 100 WVDC	1
-J7	2510-624-246	2510-424-246	CONNECTOR, male header, 34 pos.	1
-J8	2510-624-292	2510-424-292	CONNECTOR, male header, 6 pos.	1
-J9	2510-624-223	2510-424-223	CONNECTOR, male header, 26 pos.	1
-R1	2510-605-097	2510-405-097	RESISTOR, 10 kilohms ±5%, 1/4 W	1
-R2	2510-605-073	2510-405-073	RESISTOR, 1 kilohm ±5%, 1/4 W	1
-U1	4277-610-000	4477-511-000	INTEGRATED CIRCUIT, EPROM and two I/O ports	1
-XU1	2510-623-232	2510-423-232	SOCKET, 40 pins, DIP	1

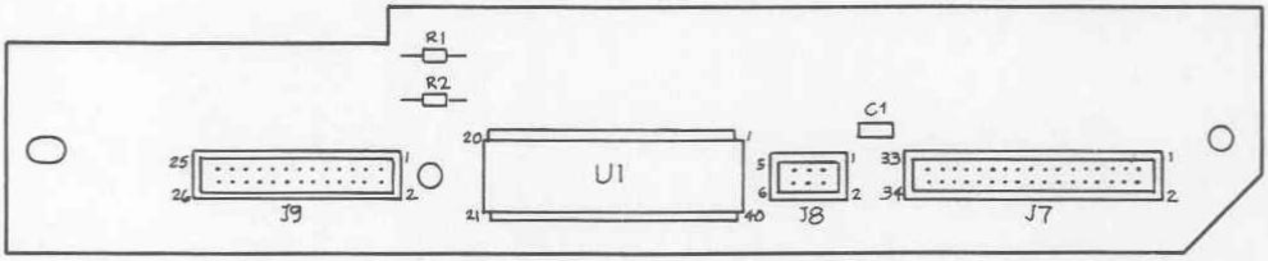


Figure 3. Printer Circuit Board

Figure & Index No.	Reorder No.	Engineering Part No.	Description 1 2 3 4 5	Quantity per Assembly
4-	Model 4225	4225-000-000	PIPETTER, venous blood	REF
-1	4701-606-002	4701-006-002	. TIP	1
-2	4225-604-001	4225-004-001	. RETAINER	1
-3	4226-603-000	---	. O-RINGS, set	REF
-3a	---	4701-001-001	. . O-RING, size 2-004	2
-3b	---	4701-002-001	. . O-RING, size 2-006	1

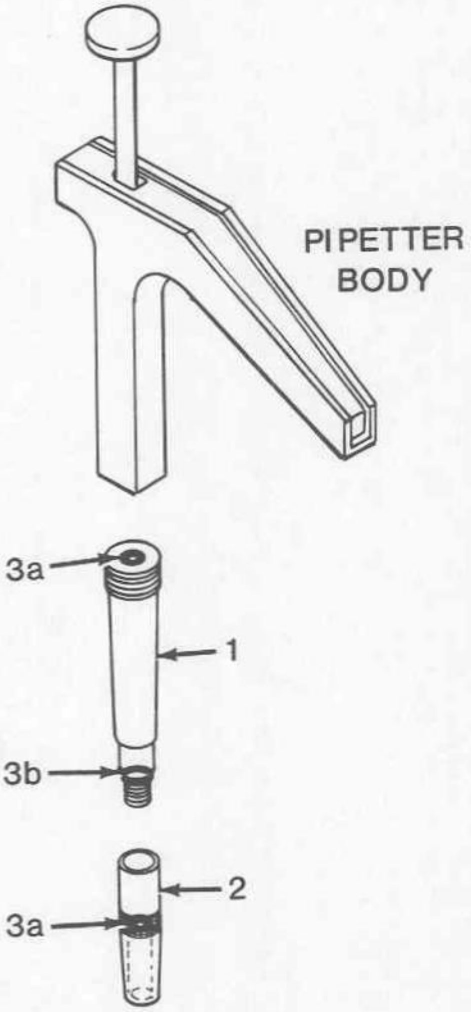
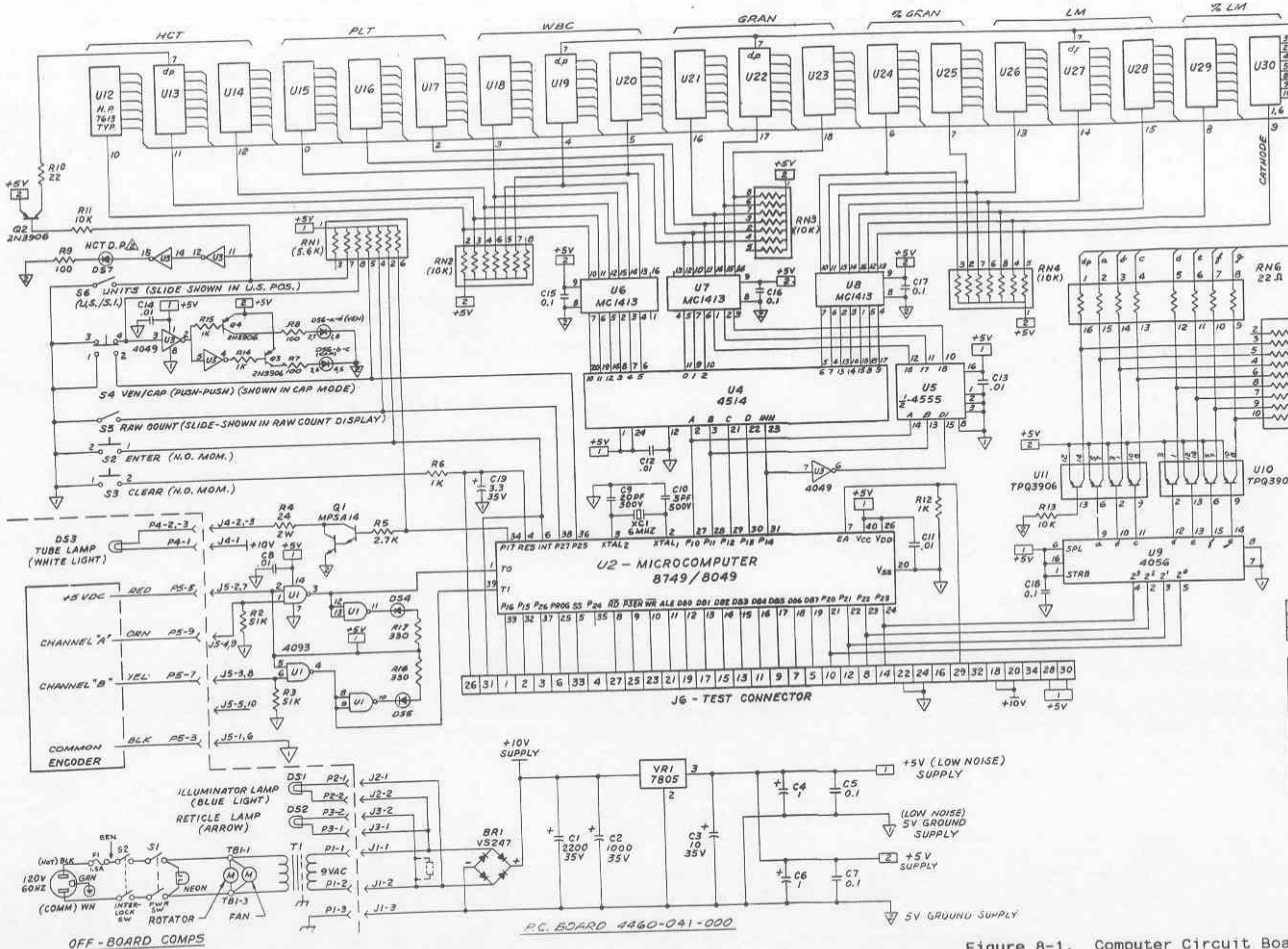


Figure 4. Venous Blood Pipetter

SECTION 8. DRAWINGS


HCT
PLT
WBC
GRAN
% GRAN
LM
% LM
U12 H.P. 7613 TYP
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U23
U24
U25
U26
U27
U28
U29
U30
dp
CATHODE
R10 22
+5V
Q2 2N3906
R11 10K
R9 100
DS7
NCT D.P.
RN1 (5.6K)
RN2 (10K)
RN3 (10K)
RN4 (10K)
RN5 10K
RN6 22 Ω
S6 UNITS (SLIDE SHOWN IN U.S. POS.) (U.S./S.I.)
C14 .01
4049
U3
R15 1K
R14 1K
Q4 2N3906
Q3 2N3906
R8 100
R7 100
DS6-a-d (VEN)
DS6-b-c (CAP)
S4 VEN/CAP (PUSH-PUSH) (SHOWN IN CAP MODE)
S5 RAW COUNT (SLIDE-SHOWN IN RAW COUNT DISPLAY)
S2 ENTER (N.O. MOM.)
S3 CLEAR (N.O. MOM.)
U6 MC1413
U7 MC1413
U8 MC1413
C15 0.1
C16 0.1
C17 0.1
U4 4514
U5 1/2-4555
C13 .01
C12 .01
U11 TPQ3906
U10 TPQ3906
R13 10K
U9 4056
SPL
STRB
C18 0.1
4049
SPARE GATES
NC
R6 1K
C19 3.3 35V
C9 20PF 500V
C10 3PF 500V
XC1 6MHZ
XTAL2
XTAL1
U2 - MICROCOMPUTER 8749/8049
EA
VCC
VDD
VSS
R12 1K
C11 .01
T0
T1
R4 24 2W
Q1 MPSA14
R5 2.7K
C8 .01
+10V
U1
4093
R2 51K
R3 51K
DS4
DS5
R17 330
R16 330
DS3 TUBE LAMP (WHITE LIGHT)
P4-2,-3
P4-1
J4-2,-3
J4-1
+5 VDC
RED
P5-5
J5-2,7
CHANNEL "A"
ORN
P5-9
J5-4,9
CHANNEL "B"
YEL
P5-7
J5-3,8
J5-5,10
COMMON
BLK
P5-3
J5-1,6
ENCODER
J6 - TEST CONNECTOR
+10V SUPPLY
VR1 7805
+5V (LOW NOISE) SUPPLY
(LOW NOISE) 5V GROUND SUPPLY
+5V SUPPLY
5V GROUND SUPPLY
C1 2200 35V
C2 1000 35V
C3 10 35V
C4 1
C5 0.1
C6 1
C7 0.1
BR1 VS247
ILLUMINATOR LAMP (BLUE LIGHT)
RETICLE LAMP (ARROW)
DS1
DS2
P2-1
P2-2
P3-2
P3-1
P1-1
P1-2
P1-3
J2-1
J2-2
J3-2
J3-1
J1-1
J1-2
J1-3
T1
9VAC
(HOT) BLK
GRN
BRN
F1 1.5A
S2
S1
120V 60HZ
(COMM) WH
INTER-LOCK SW
PWR SW
NEON
ROTATOR
TB1-1
TB1-3
FAN
OFF-BOARD COMPS
P.C. BOARD 4460-041-000

NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS 1/4W, 5%.

ALL CAPACITORS ARE IN MICROFARADS.

⚠ DS7 IS SHOWN FOR REFERENCE ONLY AND IS NOT USED ON P.C. BOARD ASSY.

LAST USED				
C19	R18 R101	RN6	BR1	VR1
Q4				

LEGEND	
▽1	5V LOW NOISE GROUND
▽2	5V GROUND
1	+5VOLTS - LOW NOISE
2	+5 VOLTS
⊕	SAFETY GROUND
⏚	CHASSIS GROUND

Figure 8-1. Computer Circuit Board and Chassis Mounted Components, Schematic Diagram

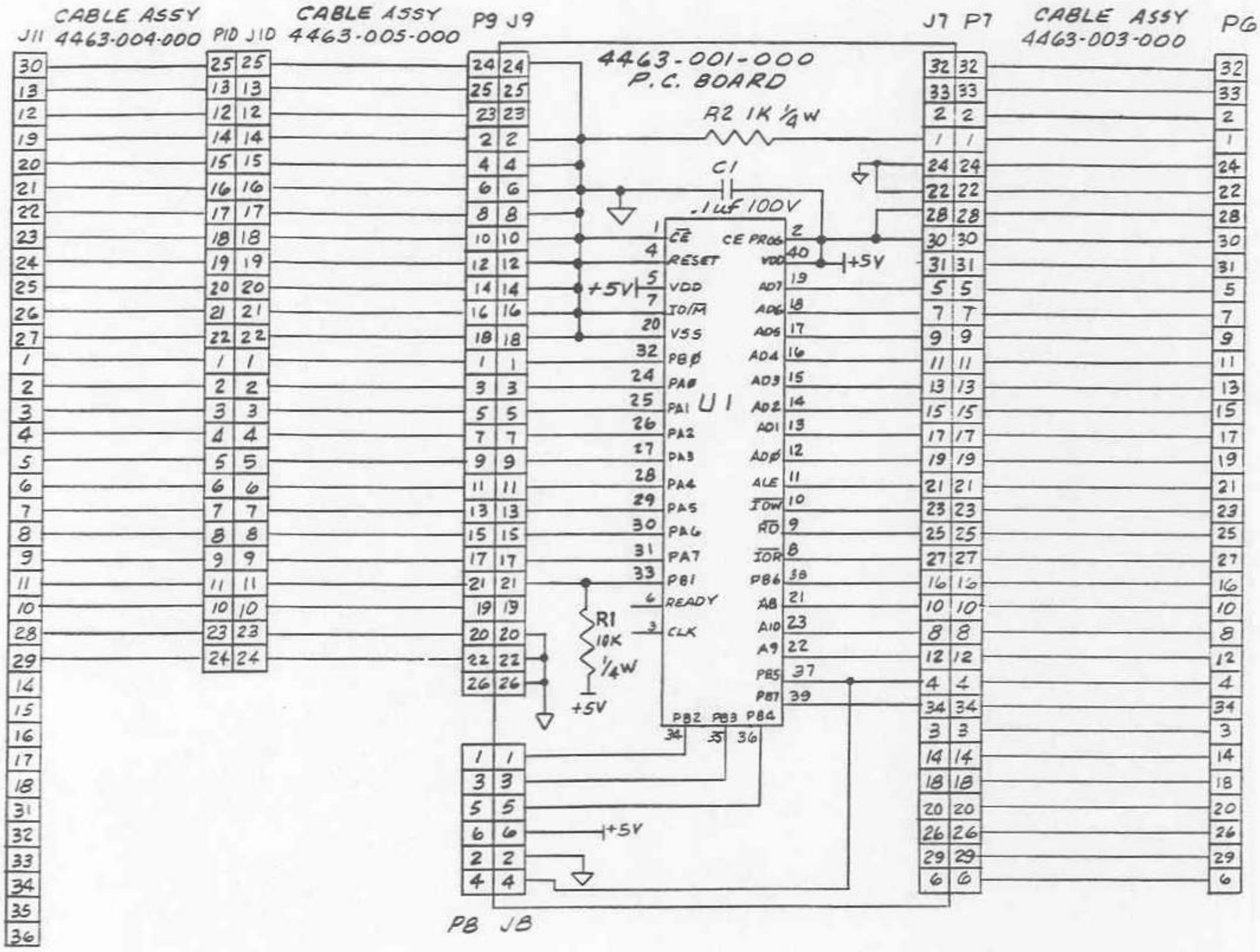
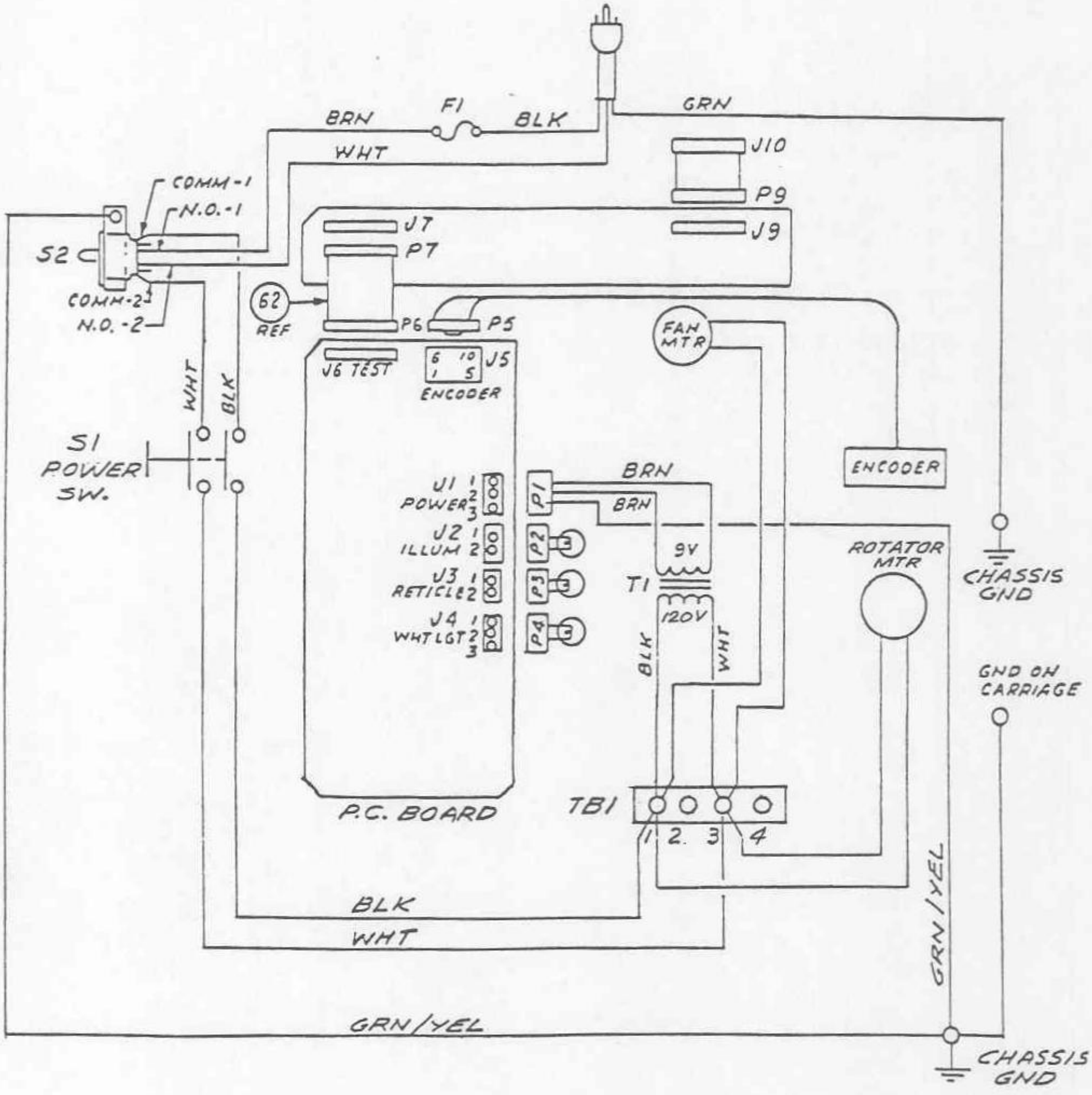

CABLE ASSY
J11 4463-004-000
P10 J10
CABLE ASSY
4463-005-000
P9 J9
4463-001-000
P.C. BOARD
R2 1K ¼W
C1
.1uf 100V
J7 P7
CABLE ASSY
4463-003-000
P6
U1
CE
RESET
VDD
IO/M
VSS
PB0
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PB1
READY
CLK
CE PROG
VDD
AD7
AD6
AD5
AD4
AD3
AD2
AD1
AD0
ALE
IOW
RD
IOR
PB6
A8
A10
A9
PB5
PB7
PB2
PB3
PB4
+5V
R1
10K
¼W
P8 J8

Figure 8-2. Printer Circuit Board, Schematic Diagram



F1
BRN
BLK
GRN
WHT
COMM-1
N.O.-1
S2
COMM-2
N.O.-2
J10
P9
J7
P7
J9
62
REF
P6
P5
J6 TEST
6 10 1 5 J5
ENCODER
FAN MTR
WHT
BLK
S1 POWER SW.
J1 1 2 3 POWER
J2 1 2 ILLUM
J3 1 2 RETICLE
J4 1 2 3 WHT LGT
P1
P2
P3
P4
BRN
BRN
9V
T1
120V
BLK
WHT
ENCODER
ROTATOR MTR
CHASSIS GND
GND ON CARRIAGE
P.C. BOARD
TB1
1 2 3 4
BLK
WHT
GRN/YEL
GRN/YEL
CHASSIS GND

Figure 8-3. QBC_{II} Reader, Internal Wiring Diagram

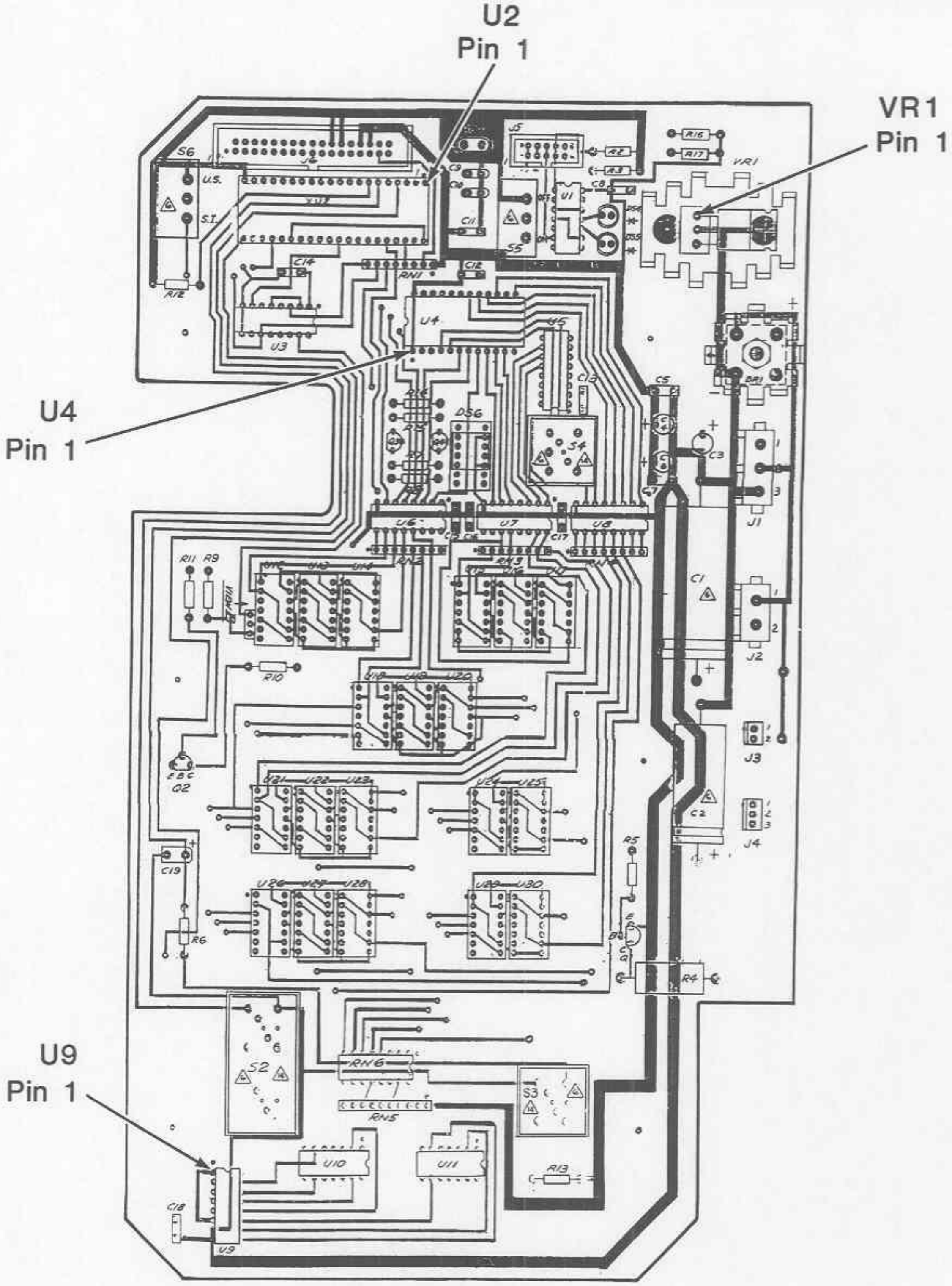
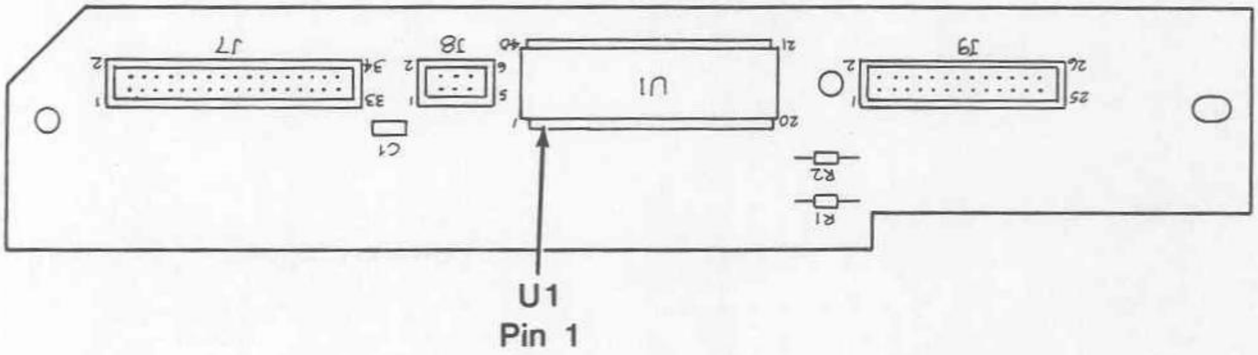

U2
Pin 1
VR1
Pin 1
U4
Pin 1
U9
Pin 1
S6
U.S.
S.I.
J6
XU2
R12
C14
U3
RN1
C12
C9
C10
C11
J5
R2
R3
U1
C8
S5
R16
R17
VR1
U4
U5
C13
R14
R15
R7
DS6
S4
C5
C4
C6
C3
BR1
J1
C7
U6
U7
U8
C15
C16
C17
RN2
RN3
RN4
R11
R9
U12
U13
U14
U15
U16
U17
C1
J2
R10
U18
U19
U20
Q2
E B C
U21
U22
U23
U24
U25
J3
C2
J4
C19
R5
U26
U27
U28
U29
U30
R6
R4
S2
RN6
RN5
S3
U10
U11
R13
C18
U9

Figure 8-4. Computer Circuit Board,
Test Point Location Diagram


J7
J8
U1
J9
C1
R2
R1
U1
Pin 1

Note: Board shown oriented as installed in QBC II Reader, facing front.

Figure 8-5. Printer Circuit Board, Test Point Location Diagram

SECTION 9. DISASSEMBLY/REASSEMBLY

9.1 READOUT DISPLAYS

a. Disconnect power cord from wall/bench receptacle.

b. Refer to Figure 5-1. Remove following parts:

  - Split rubber collar from microscope.
  - Four screws, lockwashers, and flat washers from bottom of case.

c. Lift cover straight up to remove it.

d. Remove two Phillips-head screws from right corners of display panel. (See inset in Figure 9-1.)

e. Lift up display panel (with attached power switch) from standoff posts, and lay aside panel. Do NOT disconnect power switch wires.

f. Extract defective display from pin socket on computer circuit board.

g. Orient new readout display with decimal point toward front of reader, and press display into board socket.

h. Replace display panel, using two Phillips-head screws removed in Step d.

> NOTE
>
> Before tightening panel screws, adjust panel so that there is no interference between panel cutouts and switch buttons.

i. Replace top cover, cover screws, and microscope collar by reversing Step b.

9.2 PANEL VEN/CAP LED

a. Remove top cover and display panel by performing Steps a. through e. of procedure in Paragraph 9.1.

b. Extract defective VEN/CAP LED (Figure 9-4) from socket for DS6 on computer circuit board.

c. Insert pins of new LED into socket for DS6 as shown in Figure 9-5.

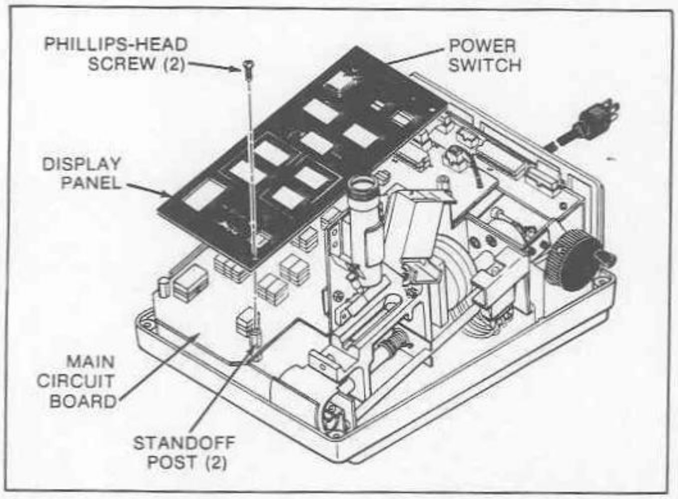

PHILLIPS-HEAD SCREW (2)
POWER SWITCH
DISPLAY PANEL
MAIN CIRCUIT BOARD
STANDOFF POST (2)

Figure 9-1. Removing Display Panel

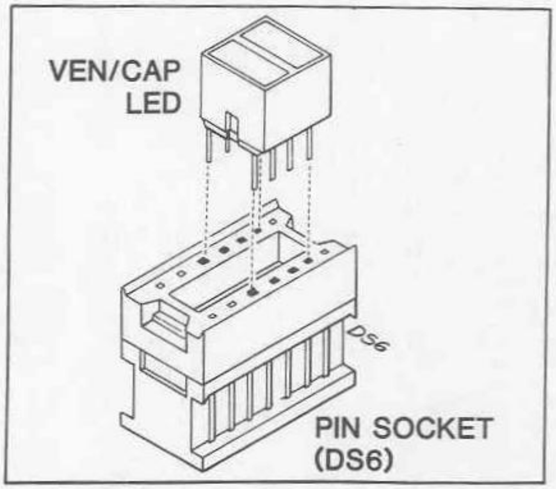

VEN/CAP LED
DS6
PIN SOCKET (DS6)

Figure 9-2. Pin Locations for LED on Socket DS6

d. Reinstall display panel and top cover by performing Steps h. and i. of procedure in Paragraph 9.1.

9.3 COMPUTER CIRCUIT BOARD ASSEMBLY

Proceed as follows to replace the computer circuit board assembly:

> **CAUTION**
>
> The computer circuit board contains MOS devices, which are subject to damage from electrostatic discharge (ESD). Refer to Paragraph 1.8 for information pertaining to proper handling.

a. Remove top cover and display panel by performing Steps a. through e. of procedure in Paragraph 9.1.

b. Disconnect wire plugs from respective connectors on circuit board as follows (see Figure 8-3):

   - Printer board ribbon cable from J6
   - Encoder plug P5 from J5
   - Transformer plug P1 from J1
   - Illuminator lamp plug P2 from J2
   - Reticle lamp plug P31 from J3
   - Tube lamp plug P4 from J4

c. Remove three hexagonal standoffs from each side of board.

d. Lift up board and place it on anti-static pad.

e. Extract 19 display devices and single VEN/CAP LED. Save for reuse.

f. Install new computer circuit board by replacing six standoffs removed in Step c.

NOTE

Be sure that standoffs with screw taps are installed in top and bottom positions on right side of board.

g. Replace wire plugs removed in Step b. on board connectors.

h. Replace readout displays removed in Step e. into sockets of board. Insert displays with decimal point toward front of reader.

i. Insert VEN/CAP LED into socket DS6. (See Step c. of procedure in Paragraph 9.2.)

CAUTION

Check that UNITS switch S6 is set to US position and RAW COUNT switch S5 is set to OFF position.

j. Reinstall display panel and top cover by performing Steps h. and i. of procedure in Paragraph 9.1.

9.4 PRINTER CIRCUIT BOARD ASSEMBLY

The printer circuit board can be replaced without removing the display panel or the computer circuit board.

> **CAUTION**
>
> The computer circuit board contains MOS devices, which are subject to damage from electrostatic discharge (ESD). Refer to Paragraph 1.8 for information pertaining to proper handling.

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 8-3. Disconnect ribbon cable connectors P7 and P9 from connectors J7 and J9, respectively, on printer circuit board.

c. Refer to Figure 9-3. Remove two Phillips-head screws and washers from ends of printer circuit board.

d. Remove defective printer circuit board. Save plastic insulator for reuse.

e. Install new printer circuit board over insulator saved in Step d.

f. Replace washers and screws.

g. Reinstall ribbon cable connectors P7 and P9 onto connectors J7 and J9 on printer circuit board.

h. Reinstall top cover and microscope collar.

9.5 POWER SWITCH

a. Remove top cover and display panel by performing Steps a. through e. of procedure in Paragraph 9.1.

b. Pry four push-on connectors from power switch terminals.

c. From rear of display panel, compress spring clips on both sides of switch assembly, and force switch out through front of panel.

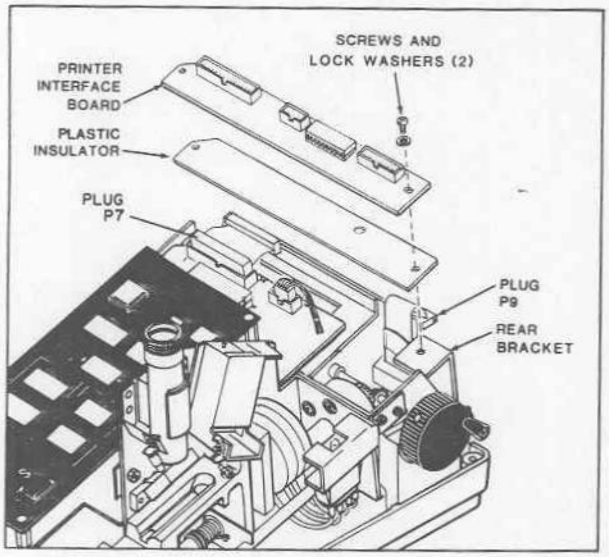

SCREWS AND
LOCK WASHERS (2)
PRINTER
INTERFACE
BOARD
PLASTIC
INSULATOR
PLUG
P7
PLUG
P9
REAR
BRACKET

Figure 9-3. Printer Circuit Board Removal

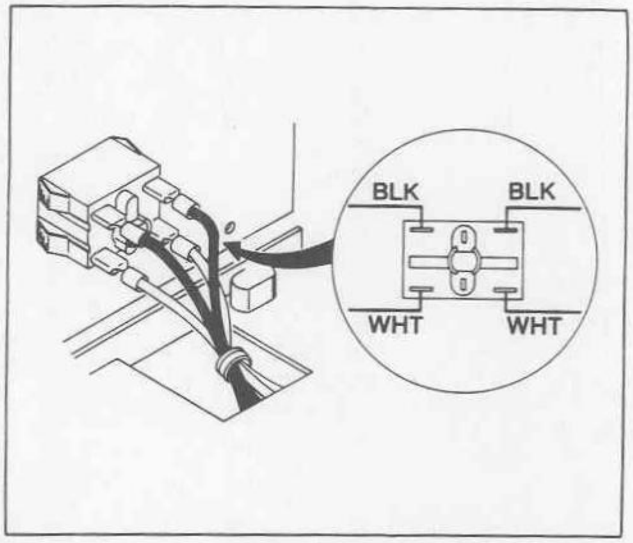

BLK
BLK
WHT
WHT

Figure 9-4. Power Switch Wiring Diagram

d. Install new power switch by compressing spring clips and pushing switch through front of display panel.

e. Refer to Figure 9-4. Reconnect four switch wires.

f. Replace display panel and top cover by performing Steps h. and i. of procedure in Paragraph 9.1.

9.6 MICROSCOPE ASSEMBLY

Proceed as follows to replace the microscope assembly:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Use sharp pencil to **mark barrel of microscope (Figure** 9-5) at top of clamp to identify original position.

c. Loosen two Phillips-head screws until microscope can be lifted out of cushion and bracket.

d. Lay defective microscope and new microscope side by side on flat surface. Mark barrel of new microscope at same distance from objective lens (lower end) as pencil mark made in Step b. on barrel of defective microscope.

e. Slide replacement microscope into mounting clamp, making sure that rubber cushion is in place.

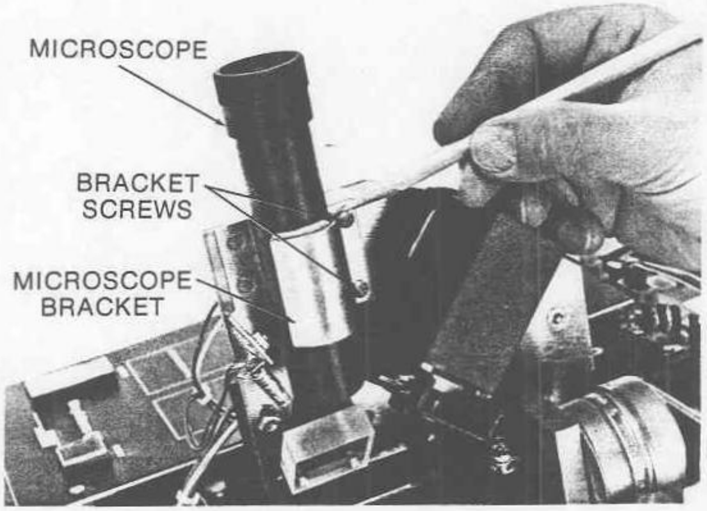


Figure 9-5. Marking Microscope Position

f. Line up pencil mark with top of clamp, and tighten clamp.

> NOTE
>
> Instead of marking microscope position on barrel, refer to Paragraph 5.4.1.2 and Figure 5-7 to adjust height so that objective lens of microscope is 1-1/2 inches above surface of tube carrier.

g. Reinstall top cover and microscope collar.

9.7 BEAM SPLITTER

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 9-6. Remove two Phillips-head screws and split lockwashers to disassemble bracket that mounts beam splitter to frame assembly.

c. Refer to Figure 9-7. Holding defective beam splitter with one hand, loosen and remove two Phillips-head screws and lockwashers to disassemble beam splitter from bracket.

d. Carefully remove protective adhesive cover from each side of new beam splitter.

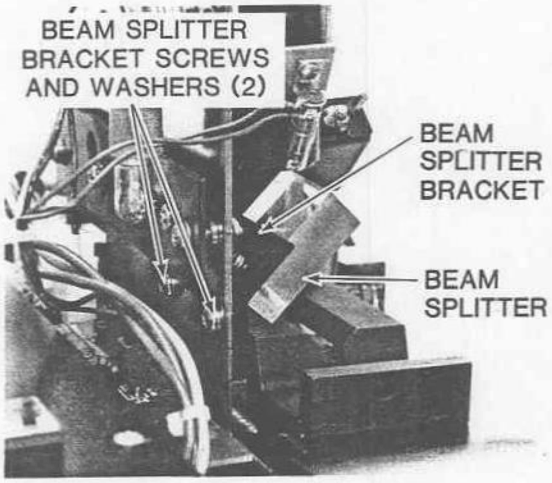

BEAM SPLITTER
BRACKET SCREWS
AND WASHERS (2)
BEAM
SPLITTER
BRACKET
BEAM
SPLITTER

Figure 9-6. **Removing Beam Splitter and Bracket**

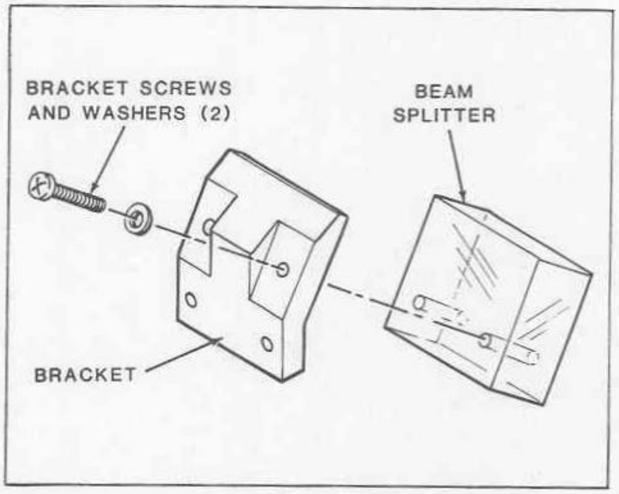

BRACKET SCREWS
AND WASHERS (2)
BEAM
SPLITTER
BRACKET

Figure 9-7. **Disassembling Bracket from Beam Splitter**

e. Mount new beam splitter onto bracket with screws and lockwashers removed in Step c. Hold part at sides to avoid smudging.

> NOTE
>
> Do not overtighten screws. Overtightening may strip threads.

f. Reinstall beam splitter bracket onto frame. Wipe upper and lower surfaces of beam splitter with lens tissue or soft cotton swab to remove dust and smudges.

g. Reinstall top cover and microscope collar.

9.8 ILLUMINATOR LAMP

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Loosen wing nut, and slide up and remove cover.

c. Pull defective illuminator lamp from lamp socket.

d. Install new illuminator lamp. Be sure lamp is fully seated and straight.

e. Wipe lamp clean with cotton or lens tissue..

f. Replace lamp cover and tighten wing nut.

g. Check light distribution of illuminator lamp by performing procedure in Paragraph 5.4.1.4.

h. Reinstall top cover and microscope collar.

9.9 ILLUMINATOR LENS

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1. Remove cover from illuminator lamp.

b. Disengage connector P2 from connector J2 on computer circuit board (Figure 8-3).

c. Refer to Figure 9-8. Remove two Phillips-head screws that attach illuminator lamp housing assembly to frame.

d. Remove complete housing assembly. Be sure to save black insulating card for reuse.

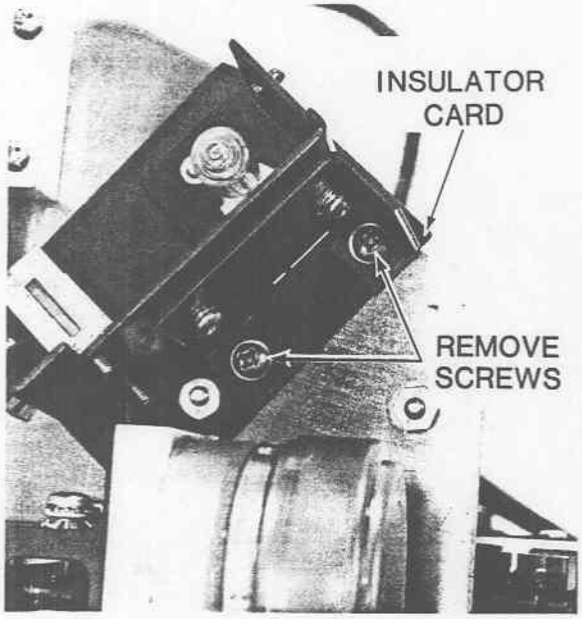


Figure 9-8. Removing Illuminator Housing Assembly

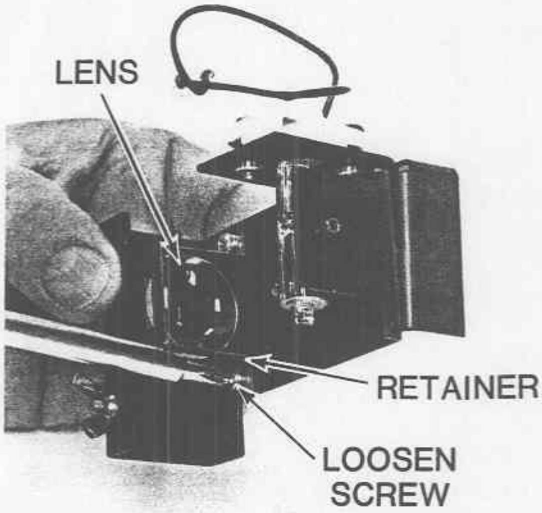


Figure 9-9. Illuminator Lens Removal Details

e. Refer to Figure 9-9. Loosen two Phillips-head screws from lens retainer, and remove defective lens.

f. Wipe new lens with lens tissue to remove dirt and smudges.

g. Install lens in retainer, and tighten retainer screws. Note that both sides of lens are convex, so lens can be oriented in either direction.

h. Replace illuminator housing. Be sure to reinstall black insulator card between housing and frame.

i. Reinstall connector P2 in connector J2 on computer circuit board.

j. Replace housing cover, and tighten wing nut.

k. Check light distribution of illuminator lamp by performing procedure in Paragraph 5.4.1.4.

l. Reinstall top cover and microscope collar.

9.10 FITC FILTER

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Remove complete illuminator lamp housing assembly by performing Steps b. through d. in Paragraph 9.9.

c. Refer to Figure 9-10. Remove two Phillips-head screws and lockwashers from filter retainer.

d. Replace defective FITC filter with new filter.

> NOTE
>
> Avoid touching filter with hands. Clean filter with lens tissue after installing it.

e. Reinstall retainer screws, illuminator housing, and illuminator lamp, and reinstall connector P2 in connector J2 on computer circuit board.

f. Check light distribution of illuminator lamp by performing procedure in Paragraph 5.4.1.4.

g. Replace top cover and microscope collar.

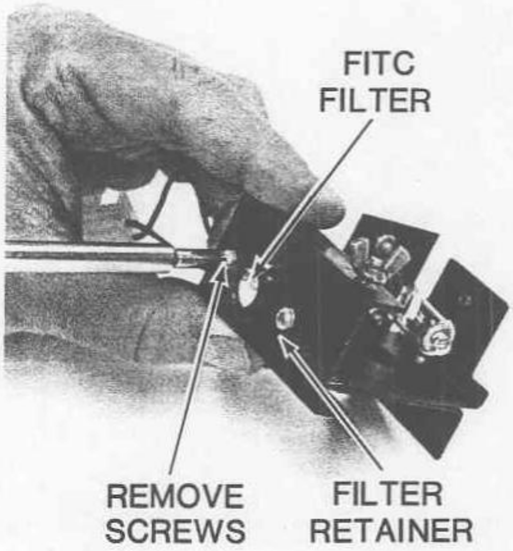


Figure 9-10. FITC Filter Installation Details

9.11 TUBE LAMP

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 9-12, and mark microscope position on barrel using sharp pencil.

c. Loosen microscope bracket screws, and slide up microscope.

d. Refer to Figure 5-14, and remove lamp from its clip socket.

e. Replace defective tube lamp with new lamp. Wipe lamp clean with lens tissue.

f. Move microscope down to original position, and tighten clamp screws.

g. Check light distribution of tube lamp by performing procedure in Paragraph 5.4.1.5.

h. Replace top cover and microscope collar.

9.12 RETICLE ARROW LAMP

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 5-8. Loosen Phillips-head screw on reticle lamp bracket.

c. Rotate bracket, and remove lamp from spring socket.

d. Replace defective arrow lamp with new lamp. Wipe lamp clean with lens tissue.

e. Rotate bracket to original position, and finger-tighten bracket screw.

f. Connect power cord, and turn on reader. Press down button of safety interlock switch.

g. Look through microscope, and adjust bracket of reticle lamp until reticle arrow appears brightest (see procedure in Paragraph 5.4.1.1). Turn off power.

h. Tighten reticle lamp bracket.

i. Replace top cover and microscope collar.

9.13 RETICLE FILM AND DIFFUSER

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 5-9. Remove three Phillips-head screws ("A" and "B") and washers from reticle arrow bracket assembly to disassemble bracket.

c. Refer to Figure 9-11. Using 1/4-inch hex wrench, remove two nuts with lockwashers from bracket to disassemble reticle film, diffuser, and retainer. Discard old reticle film and diffuser.

d. Install new diffuser and reticle film set onto retainer screws, and insert retainer into bracket.

e. Center arrow in small circular window of bracket as shown in Figure 9-11.

f. Install lockwashers, and tighten retainer nuts.

g. Reinstall reticle bracket assembly screws and washers, with longer screw "B" in front position. Finger-tighten bracket screws.

h. Perform adjustment procedures for reticle arrow overlap and parallax in accordance with Paragraphs 5.4.1.2 and 5.4.1.3, respectively.

i. Replace top cover and microscope collar.

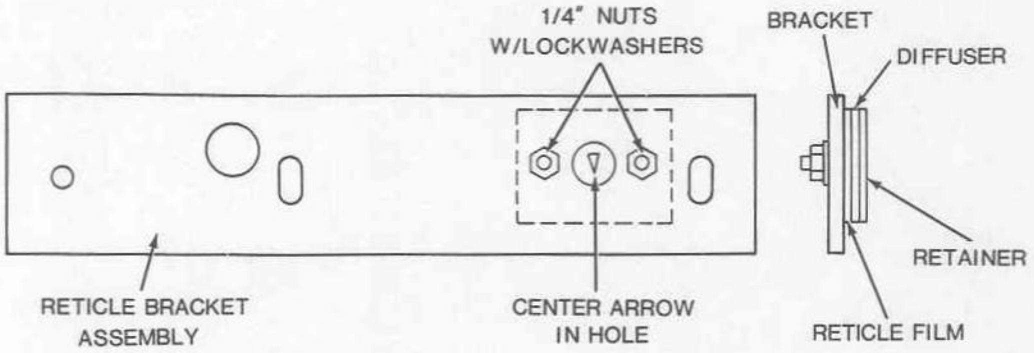

1/4" NUTS
W/LOCKWASHERS
BRACKET
DIFFUSER
RETAINER
RETICLE BRACKET
ASSEMBLY
CENTER ARROW
IN HOLE
RETICLE FILM

Figure 9-11. Bracket, Film, and Diffuser Details

9.14 ROTATOR MOTOR ASSEMBLY

a. Remove top cover, display panel, and computer circuit board by performing Steps a. through d. of procedure in Paragraph 9.3.

b. Refer to Figure 9-12. Disconnect orange motor wires from terminals on strip TB1.

c. Cut cable tie from orange motor wires and green/yellow ground wire.

d. Refer to Figure 9-13. Using angled nut driver, remove hex screw "A," flat washer, lockwasher, and cable clamp from carriage frame to free motor wires and green/yellow wire. Do not loosen screw "B."

e. Remove two Phillips-head screws that secure motor and harness assembly to mounting plate. (Angled screwdriver is needed for lower screw.)

f. Pull motor straight back to free motor shaft pin from universal joint.

g. For ease of reassembly, remove two screws, mounting plate (Figure 9-14), and universal joint. Save these items for reuse in Steps h. through j.

h. Wrap small piece of paper and plastic tape around universal joint to make rigid piece.

i. Push universal joint through hole in carriage, and press joint onto rotator shaft and shaft pin (Figure 9-15).

j. Align mounting plate, and reinstall with screws removed in Step g.

k. Using new rotator motor and harness assembly, slip orange motor wire underneath frame.

l. Push universal joint in direction of motor while pressing shaft of motor into universal joint.

m. Rotate and press motor or universal joint until motor shaft pin is locked into slot of universal joint.

n. Press motor against mounting plate until shaft hub is in hole and motor is flush with mounting plate.

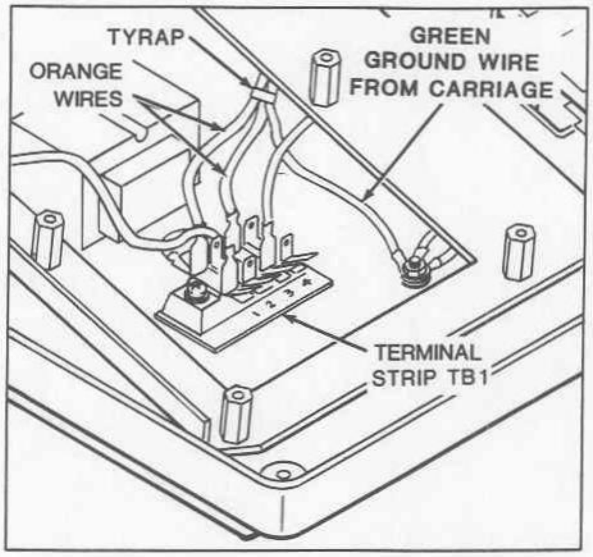

TYRAP
ORANGE WIRES
GREEN GROUND WIRE FROM CARRIAGE
TERMINAL STRIP TB1
1
2
3
4

Figure 9-12. Disconnecting Tube Rotator Motor Wires from Terminal Strip TB1

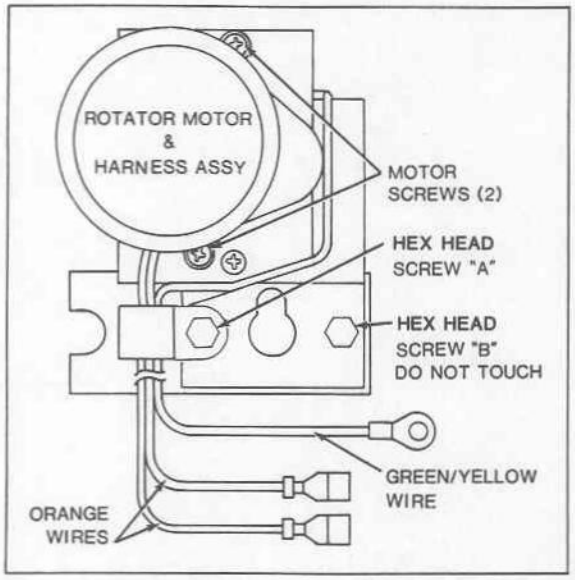

ROTATOR MOTOR & HARNESS ASSY
MOTOR SCREWS (2)
HEX HEAD SCREW "A"
HEX HEAD SCREW "B" DO NOT TOUCH
GREEN/YELLOW WIRE
ORANGE WIRES

Figure 9-13. Rotator Motor Details

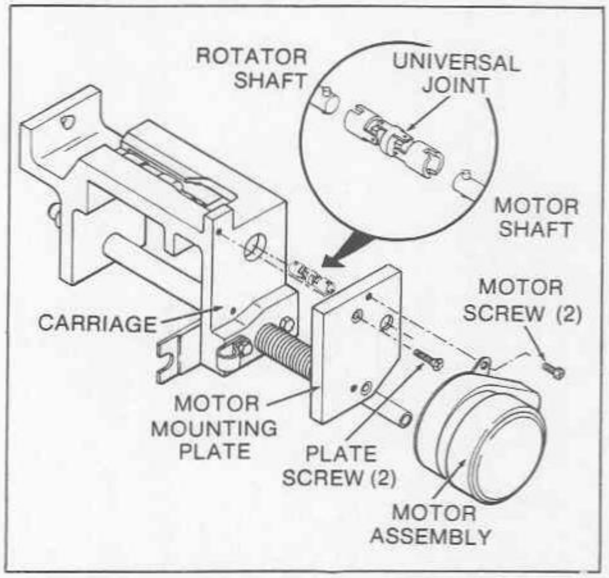

ROTATOR SHAFT
UNIVERSAL JOINT
MOTOR SHAFT
MOTOR SCREW (2)
CARRIAGE
MOTOR MOUNTING PLATE
PLATE SCREW (2)
MOTOR ASSEMBLY

Figure 9-14. Removing Motor Mounting Plate and Universal Joint

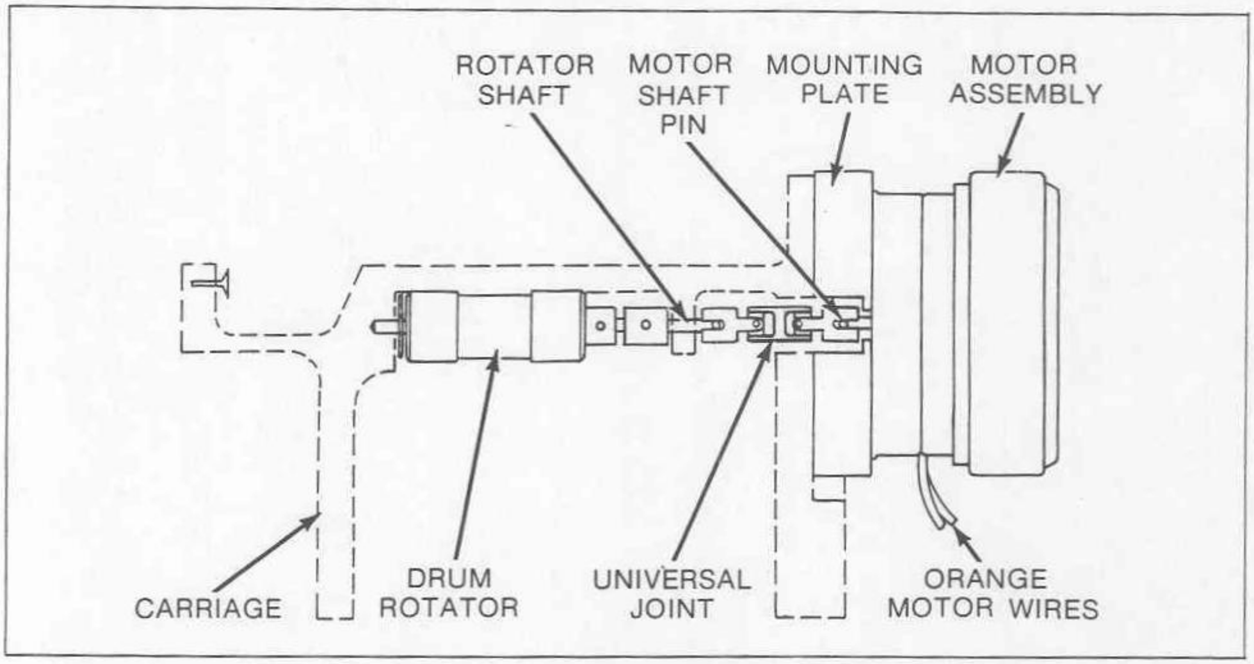

ROTATOR SHAFT
MOTOR SHAFT PIN
MOUNTING PLATE
MOTOR ASSEMBLY
CARRIAGE
DRUM ROTATOR
UNIVERSAL JOINT
ORANGE MOTOR WIRES

Figure 9-15. **Motor Installation Details**

o. Reinstall motor mounting screws removed in Step e.

p. Remove tape and paper installed on universal joint in Step h.

q. Connect orange wires to terminals 1 and 3 of TB1.

> NOTE
>
> Dress wires underneath frame so that carriage can travel up and down lead screw without interference from wires.

r. Reinstall cable clamp, washers, and hex screw over orange motor wires and green/yellow ground wire.

s. Reinstall computer circuit board following reassembly steps of procedure in Paragraph 9.3.

t. Replace display panel, top cover, and microscope collar.

9.15 MOTOR MOUNTING PLATE

a. Remove rotator motor, mounting plate, and universal joint by performing Steps a. through h. of procedure in Paragraph 9.14.

b. Using new mounting plate, reinstall universal joint, plate, and motor by performing Steps i. through t. of procedure in Paragraph 9.14.

9.16 UNIVERSAL JOINT

a. Remove rotator motor, mounting plate, and universal joint by performing Steps a. and h. of procedure in Paragraph 9.14.

b. Using new universal joint, install universal joint, plate, and motor by performing Steps i. through t. of procedure in Paragraph 9.14.

9.17 ROTATOR DRUM

a. Remove rotator motor, mounting plate, and universal joint by performing Steps a. and h. of procedure in Paragraph 9.14.

b. Refer to Figure 9-16. Loosen set screws in spacer and in rotator drum.

c. Pull rotator shaft through hole in carriage, and remove spacer, drum, and Teflon washer.

d. Assemble washer, new rotator drum, and spacer loosely on rotator shaft in carriage assembly.

e. Install universal joint, mounting plate, and motor by performing Steps h. through o. of procedure in Paragraph 9.14.

f. Push universal joint in direction of motor until it bottoms.

g. Push shaft in direction of motor until it bottoms.

h. Insert 0.025-inch gapping shim between Teflon washer and carriage (see Figure 9-16).

i. With 0.025-inch shim still in position, push drum and washer and Teflon washer toward thrust pivot.

j. Lock rotator drum to shaft by tighting drum set screw. Remove 0.025 shim.

k. Insert 0.015-inch gapping shim between spacer and carriage (see inset, Figure 9-16).

l. Push drum toward thrust pivot and spacer toward motor; then lock spacer to shaft by tighting set screw. Remove 0.015 shim.

m. Complete reassembly of all parts by performing Steps p. through t. of procedure in Paragraph 9.14.

9.18 ROTATOR SHAFT ASSEMBLY

Install a new rotator shaft assembly by performing Steps a. through l. of procedure in Paragraph 9.17.

9.19. THRUST PIVOT

A defective or broken thrust pivot can be replaced without removing the top cover; however, accessibility is improved when the cover is removed.

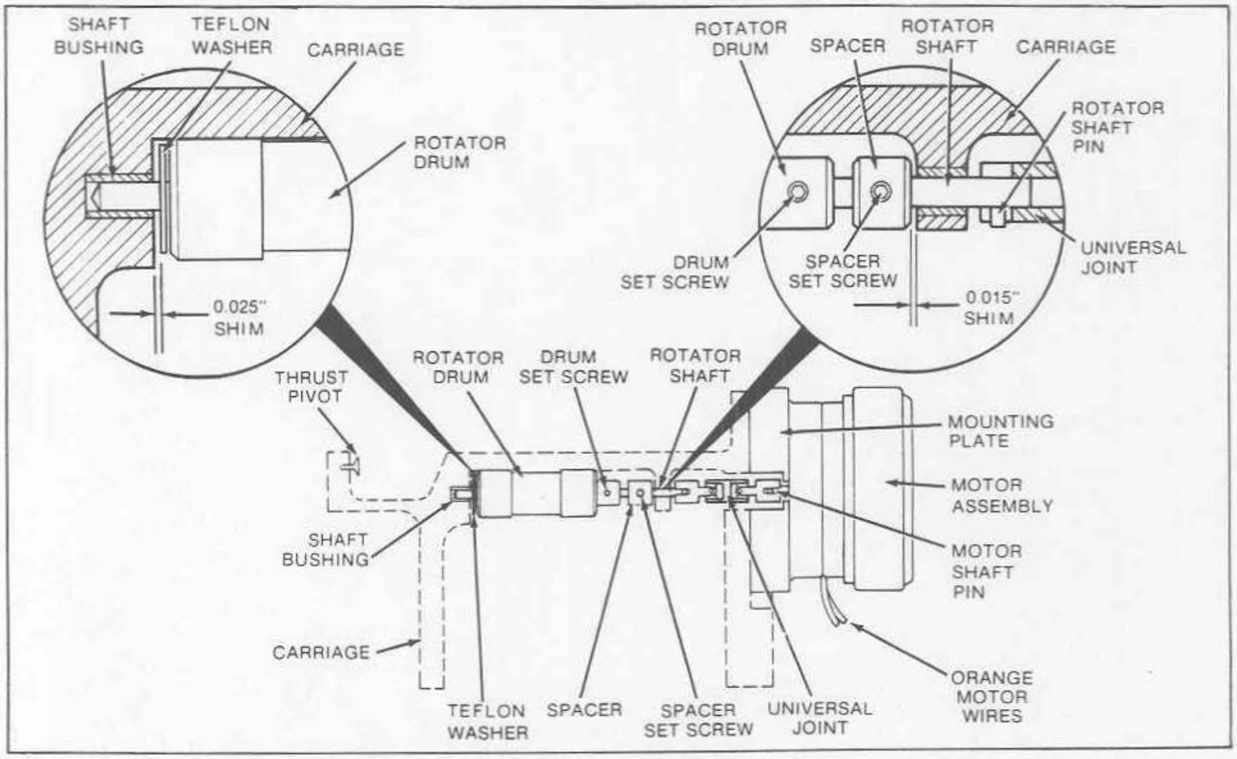

SHAFT BUSHING
TEFLON WASHER
CARRIAGE
ROTATOR DRUM
0.025" SHIM
ROTATOR DRUM
SPACER
ROTATOR SHAFT
CARRIAGE
ROTATOR SHAFT PIN
UNIVERSAL JOINT
DRUM SET SCREW
SPACER SET SCREW
0.015" SHIM
THRUST PIVOT
ROTATOR DRUM
DRUM SET SCREW
ROTATOR SHAFT
MOUNTING PLATE
MOTOR ASSEMBLY
MOTOR SHAFT PIN
SHAFT BUSHING
CARRIAGE
ORANGE MOTOR WIRES
TEFLON WASHER
SPACER
SPACER SET SCREW
UNIVERSAL JOINT

Figure 9-16. Rotator Drum Installation Details

NOTE

The thrust pivot replacement kit contains a smooth-stem thrust pivot, a barbed-stem thrust pivot, an inner socket, and an outer socket. Use both sockets, but use only the barbed-stem thrust pivot for replacement as shown in Figure 9-17. (Discard the smooth-stem thrust pivot.)

Replace the thrust pivot assembly as follows:

a. Refer to Figure 9-18. Push in old thrust pivot until inner socket protrudes from or pops out of rear of carriage. Save old inner socket for use in Step b.

b. Place old inner socket in recess and against outer socket as shown in Figure 9-19.

c. Press outer socket with pliers until it protrudes from rear of carriage.

d. Grasp outer socket with pliers and remove it. Discard old parts.

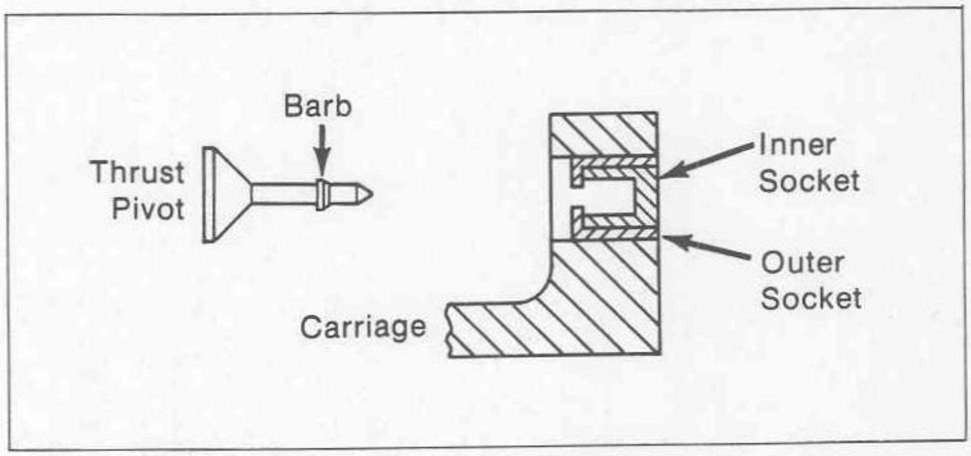


Figure 9-17. Thrust Pivot Replacement Parts

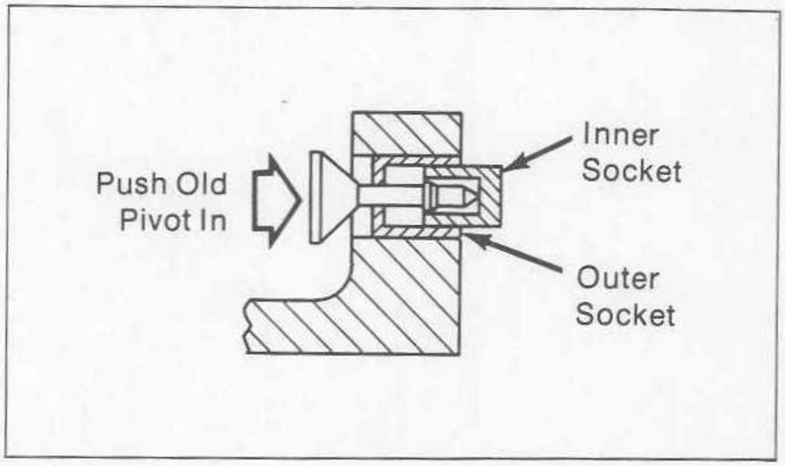

Push Old
Pivot In
Inner
Socket
Outer
Socket

Figure 9-18. Removing Inner Pivot Socket

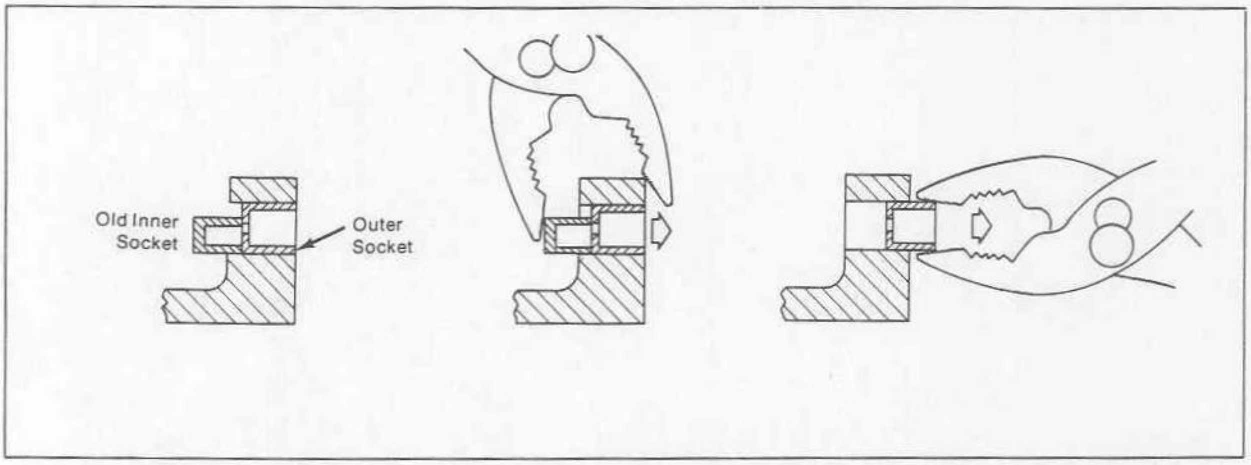

Old Inner
Socket
Outer
Socket

Figure 9-19. Removing Outer Pivot Socket

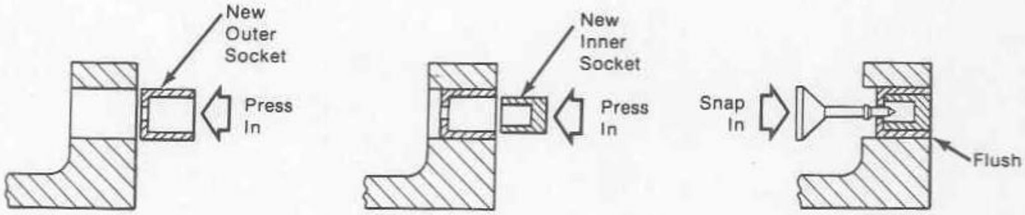


Figure 9-20. Installing Thrust Pivot Sockets and Pivot

e. Press new outer socket into carriage as shown in Figure 9-20. Use pliers, if necessary, until socket is flush with rear of carriage hole.

f. Press new inner socket into outer socket as shown in Figure 9-20.

g. Push in thrust pivot until it snaps into place.

NOTE

Inner socket piece may move when snapping in pivot. If socket moves, push it back until it is flush with carriage.

9.20 SHIELD ASSEMBLY

The carriage and optics assembly need not be removed to replace the shield assembly, which is mounted beneath the front end of the carriage. Perform the following procedure to replace a damaged or defective shield assembly:

a. Remove top cover by performing Steps a. through c. of the procedure in Paragraph 9.1.

b. Refer to Figure 9-21. Turn transport shaft to move carriage inward until front end of carriage clears front of lower frame.

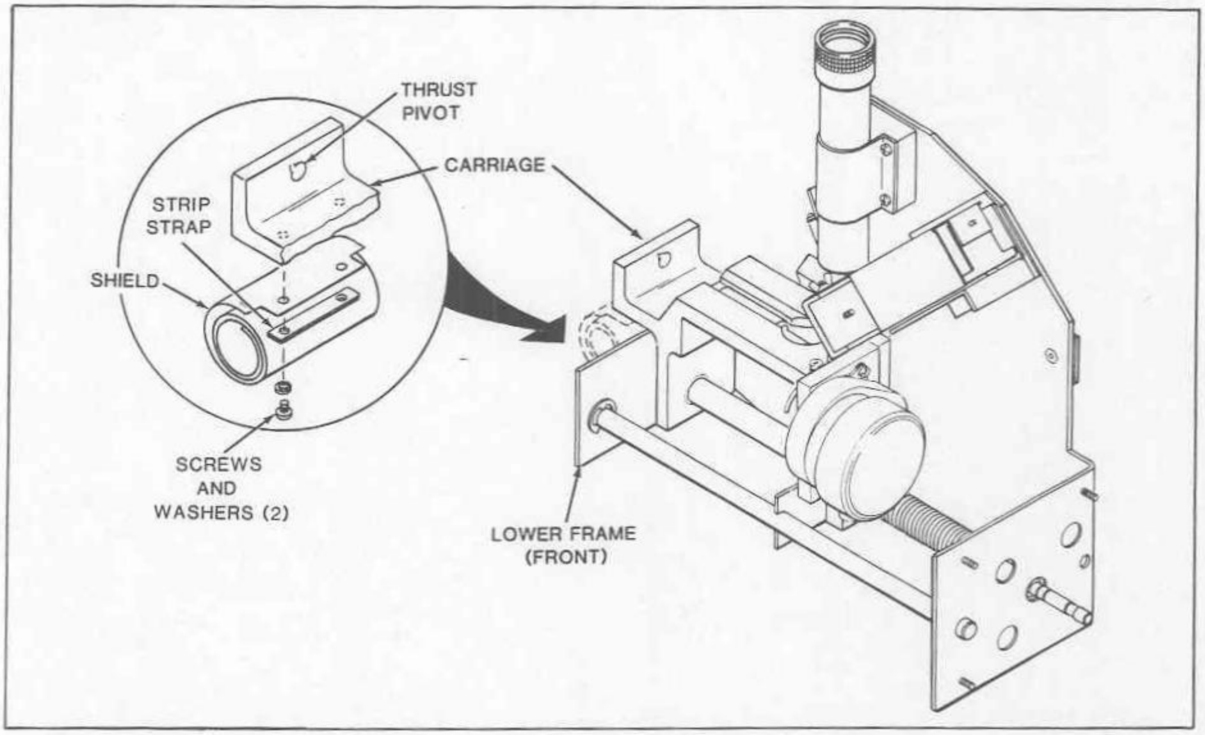


Figure 9-21. Shield Details

c. Use angled screwdriver to remove two Phillips-head screws, washers, and strip strap from bottom of carriage. Remove coiled shield.

d. Install replacement shield by replacing strap, washers, and screws.

e. Replace top cover and microscope collar.

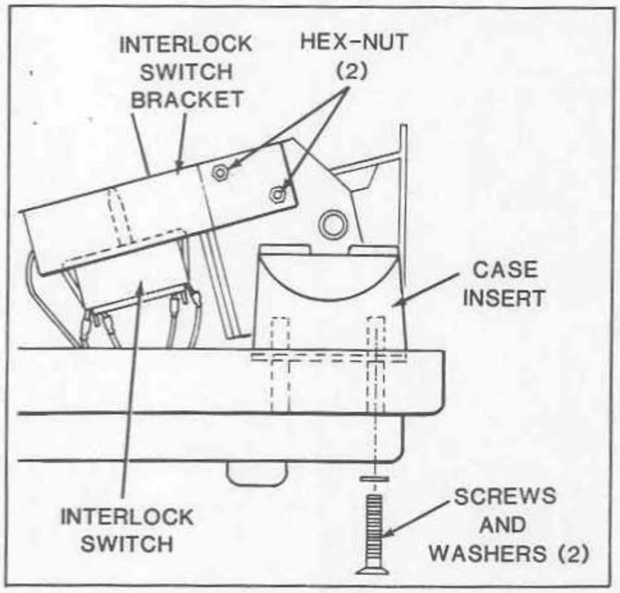
9.21 FRAME AND MECHANISM ASSEMBLY

To replace a preassembled frame and mechanism assembly, the complete carriage and optics assembly must be removed first, followed by disassembly of reusable optics components. Proceed as follows:

a. Remove top cover, display panel, and computer circuit board by performing Steps a. through d. of procedure in Paragraph 9.3.

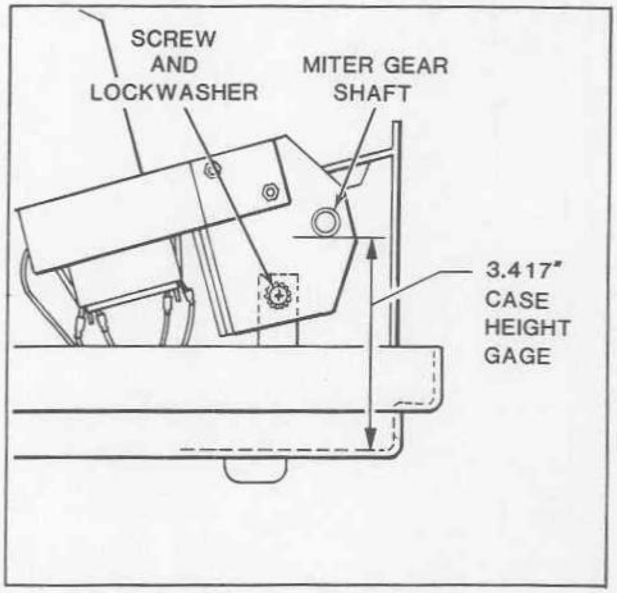
b. Disconnect orange motor wires from terminals on strip TB1 (see Figure 9-12). Remove hex nut and washer to disconnect green/yellow carriage ground wire from terminal in bottom of chassis.

c. Refer to Figure 9-22. Remove two hex nuts and lockwashers from safety switch assembly bracket.



INTERLOCK SWITCH BRACKET
HEX-NUT (2)
CASE INSERT
INTERLOCK SWITCH
SCREWS AND WASHERS (2)

Figure 9-22. Disassembling Interlock Switch Bracket from Chassis



SCREW AND LOCKWASHER
MITER GEAR SHAFT
3.417" CASE HEIGHT GAGE

Figure 9-23. Disassembling Miter Gear Bracket Assembly from Chassis

d. Remove transport knob by loosening two set screws in knob.

e. Remove two screws, lockwashers, and flat washers from bottom side of case to remove case insert (see Figure 5-22).

f. Remove Phillips-head screw and lockwasher (Figure 9-23) that support miter gear frame to chassis.

g. Use long-stem Phillips-head screwdriver (8 inches, minimum) to remove three screws (Figure 9-24) that secure frame to chassis.

h. Remove complete carriage and optics assembly from chassis, being careful to slide coiled shield gently from its front guide.

i. Remove optical and mechanical components from carriage and carriage assembly for later installation on replacement frame and mechanism assembly as follows:

   1. Microscope, clamp and cushion, block, and hardware (see Paragraph 9.6).

   2. Beam splitter, bracket, and hardware (see Paragraph 9.7).

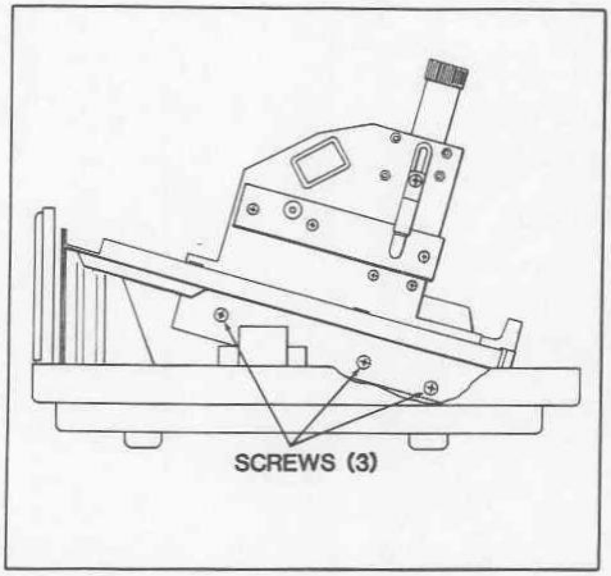


Figure 9-24. Disassembling Left Side of Frame Assembly from Chassis

3. Illuminator lamp, lens, filter, housing, insulator card, socket assembly, and hardware (see Paragraphs 9.7 through 9.10).

4. Tube lamp, socket assembly, and hardware (see Paragraph 9.11).

5. Reticle arrow lamp, bracket assembly, and hardware (see Paragraph 9.12).

6. Reticle arrow bracket assembly and hardware (see Paragraph 9.13).

7. Shield, strip strap, and hardware (see Paragraph 9.20).

j. Assemble shield and strap on new frame and mechanism assembly. Then install replacement frame and mechanism assembly by performing Steps c. through g. of this procedure in reverse order.

k. Refer to Figure 9-23 before tightening Phillips-head screw and lockwasher that mount miter gear bracket of frame to chassis. Place miter gear shaft height gauge between bottom of miter gear shaft and inside floor of lower case. With gear shaft resting on gauge 3.417 inches high, tighten bracket screw.

NOTE

On replacement frame and mechanism assembly the carriage, rotator assembly, encoder, and miter gears are prealigned.

l. Replace optics components removed in Step i. Refer to applicable procedures referenced in that step.

m. Connect orange motor wires to terminals 1 and 3 on TB1, and connect green/yellow carriage ground wire to terminal in bottom of chassis (Figure 9-12).

n. Reinstall computer circuit board and appropriate cable connectors to board connectors J1 through J5. Replace display panel.

o. Check lead screw and guide rod for adequate lubrication. See procedure in Paragraph 5.3.2, and lubricate as necessary.

p. Check optics by performing procedures in Paragraphs 5.4.1.1 through 5.4.1.5, and make adjustments as necessary.

q. Replace top cover and microscope collar.

9.22 MITER GEARS

Miter gears always must be replaced in sets. Worn or defective gears can be replaced without removing the frame assembly as follows:

a. Remove top cover and printer circuit board by performing Steps a. through c. of procedure in Paragraph 9.4.

b. Remove transport knob (optional) by using hex key to loosen two set screws in knob.

c. Use hex key to loosen two set screws of miter gear on main shaft (Figure 9-26). Remove retaining ring from main shaft. Pull gear shaft out of bracket bearing. Save washers and retaining ring.

d. Loosen two set screws in miter gear on end of lead screw, and remove gear.

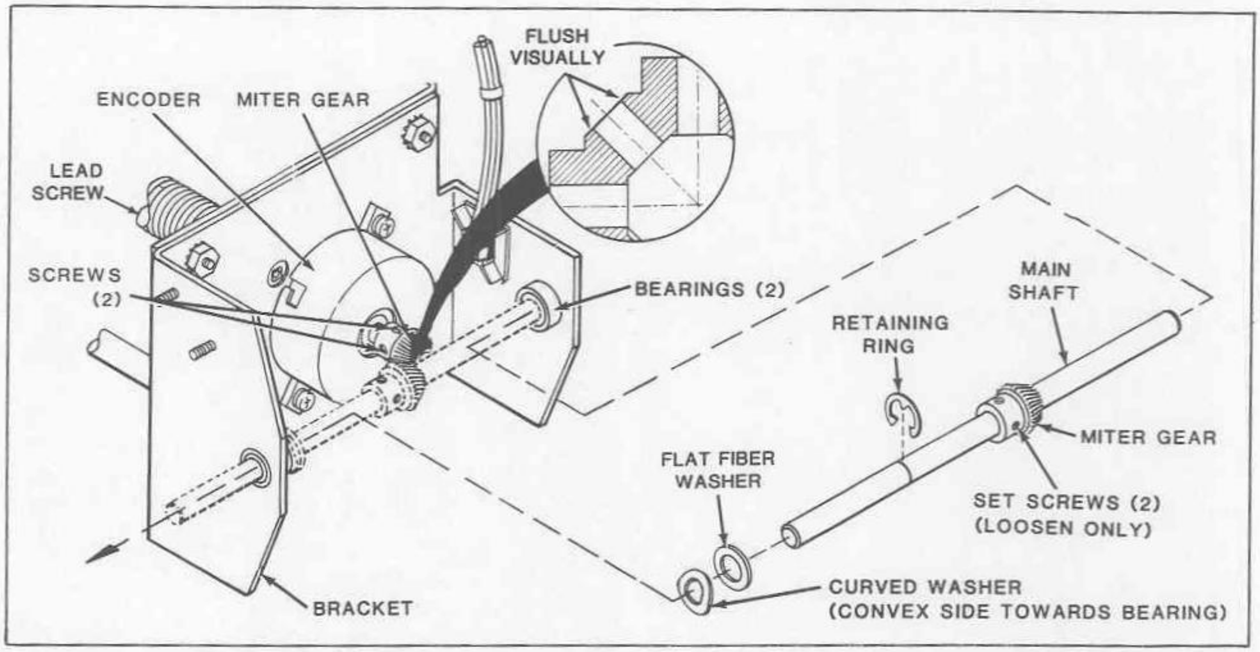

FLUSH VISUALLY
ENCODER
MITER GEAR
LEAD SCREW
SCREWS (2)
BEARINGS (2)
MAIN SHAFT
RETAINING RING
MITER GEAR
FLAT FIBER WASHER
SET SCREWS (2) (LOOSEN ONLY)
CURVED WASHER (CONVEX SIDE TOWARDS BEARING)
BRACKET

Figure 9-25. Disassembling Miter Gear and Gear Shaft

e. Using new miter gear set, place one gear on end of lead screw. Do not tighten lead screw.

f. Refer to Figure 9-25. Slide gear shaft through bracket bearing, and install curved washer and fiber washer. Slide new gear onto shaft, and push shaft through other bracket bearing. Snap on retaining ring.

g. With miter gears on shaft and on lead screw meshed, pull transport knob or gear shaft until retaining ring, fiber washer, and curved washer make contact with outer bearing of gear bracket.

h. With mating faces of gears fully flush (see inset in Figure 9-25), tighten set screws in each miter gear (6-8 inch-pounds).

i. Apply Glyptal to set screws.

j. Replace transport knob if removed previously.

k. Replace printer circuit board, top cover and microscope collar.

9.23 OPTICAL ENCODER

The optical encoder can be replaced without removing the frame assembly; however, both miter gears must be removed first:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Disassemble miter gears by performing Steps a. through d. of procedure in Paragraph 9.22.

c. Disconnect cable connector containing black, red, orange, and yellow wires from connector J5 on computer circuit board. (See Figure 8-3.)

d. Cut cable tie from encoder wires at cable clamp located on inside surface of miter gear frame.

e. Refer to Figure 9-26. Insert blade of thin flat screwdriver at upper snap-on point of encoder cover, and partially pry up cover.

f. With long-stem screwdriver inserted through upper hole in back plate (Figure 9-27), remove Phillips-head screw and washer from upper mounting flange of encoder reticle body.

g. Remove lower screw and washer from encoder body through lower hole in back plate (Figure 9-27).

h. Rotate reticle body of encoder 180 degrees. With screwdriver, pry off encoder cover from lower snap-on point.

i. Refer to Figure 9-28. Use hex key to loosen set screw in encoder disc and hub assembly. Remove complete encoder from lead screw shaft.

j. Using new optical encoder, leave shipping band in place (Figure 9-29), and slide hub of disc onto lead screw shaft.

k. Reinstall upper and lower screws and washers removed from encoder reticle body in Steps f. and g.

l. Remove shipping band from encoder (Figure 9-29).

m. Insert hex key into set screw in hub of disc, and lightly press hub toward mounting surface until stop is felt. (Note that new encoder incorporates built-in 0.010-inch gapping plug.)

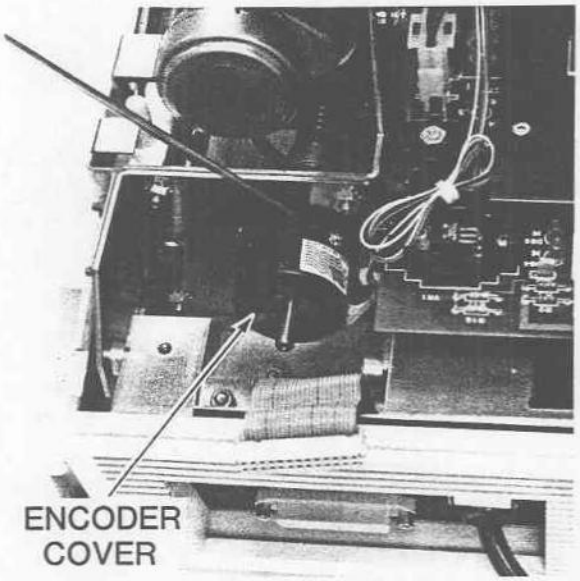

ENCODER
COVER

Figure 9-26. Encoder Installation Details

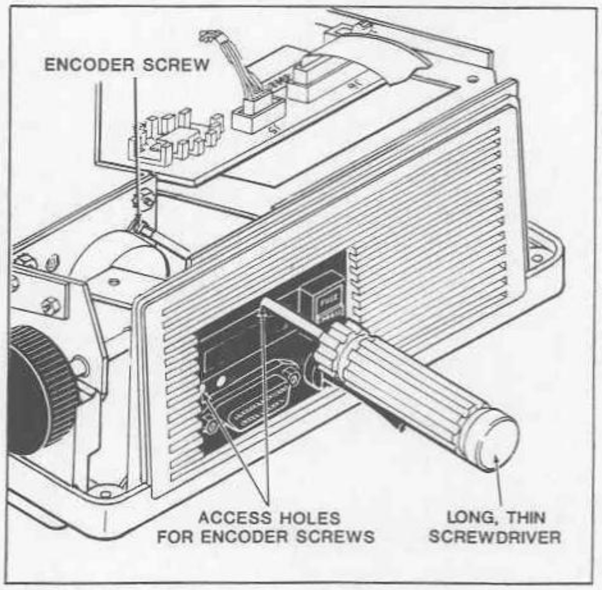

ENCODER SCREW
ACCESS HOLES
FOR ENCODER SCREWS
LONG, THIN
SCREWDRIVER

Figure 9-27. Access Holes for Encoder Screws

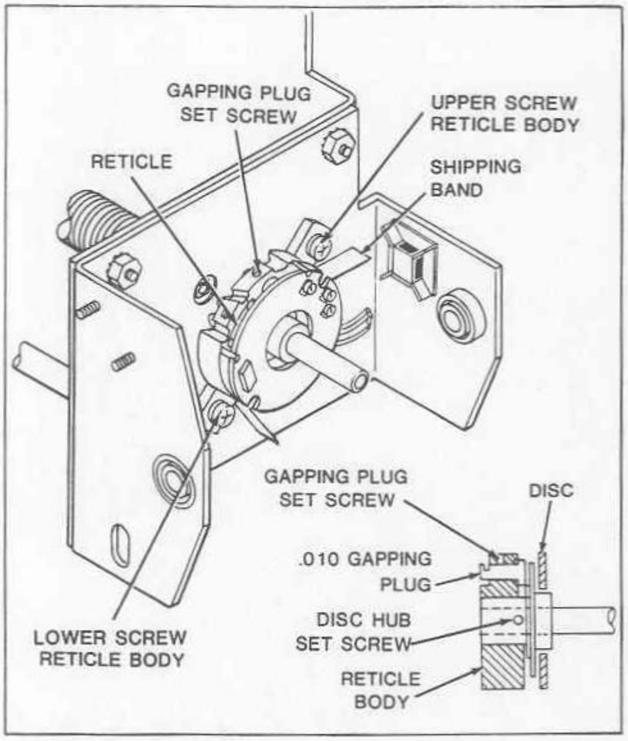

GAPPING PLUG
SET SCREW
UPPER SCREW
RETICLE BODY
RETICLE
SHIPPING
BAND
GAPPING PLUG
SET SCREW
DISC
.010 GAPPING
PLUG
DISC HUB
SET SCREW
LOWER SCREW
RETICLE BODY
RETICLE
BODY

Figure 9-28. Encoder Disc Set Screw and Gapping Details

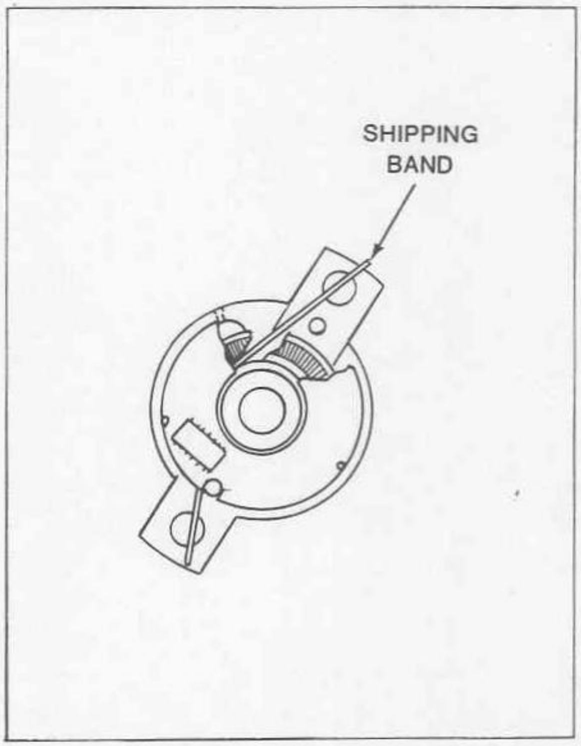

SHIPPING
BAND

Figure 9-29. Encoder Shipping Band

n. Tighten set screw of hub.

o. Locate set screw of gapping plug on left side of reticle body (Figure 9-28).

p. Loosen set screw 1/2 turn. Referring to inset in Figure 9-28, pry down gapping plug with small screwdriver until plug is flush with reticle body.

q. Retighten set screw 1/2 turn.

r. Orient cover to clear encoder wires, and snap cover into place. Add one drop of Glyptal to each encoder reticle body screw.

s. Engage encoder cable connector with connector J5 on computer circuit board.

t. Install cable tie around encoder wires and cable clamp located on inside of miter gear frame.

u. Reinstall miter gears, transport knob, printer circuit board, and top cover by performing Steps a. through k. of procedure in Paragraph 9.22.

9.24 LEAD SCREW

The complete carriage and optics assembly must be removed from the reader to allow further disassembly so that the lead screw can be replaced:

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Remove carriage and optics assembly by performing Steps a. through h. of procedure in Paragraph 9.21.

c. Lay assembly on flat, clean surface. Wipe as much grease as possible from lead screw, guide rod, and other parts to prevent contamination of other components.

d. Remove miter gears and optical encoder by performing Steps b. and e. through i. of procedure in Paragraph 9.23.

e. Refer to Figure 9-30. Remove retaining ring and spacer from lead screw shaft.

f. Remove three hex Keps nuts from miter gear bracket, and remove bracket.

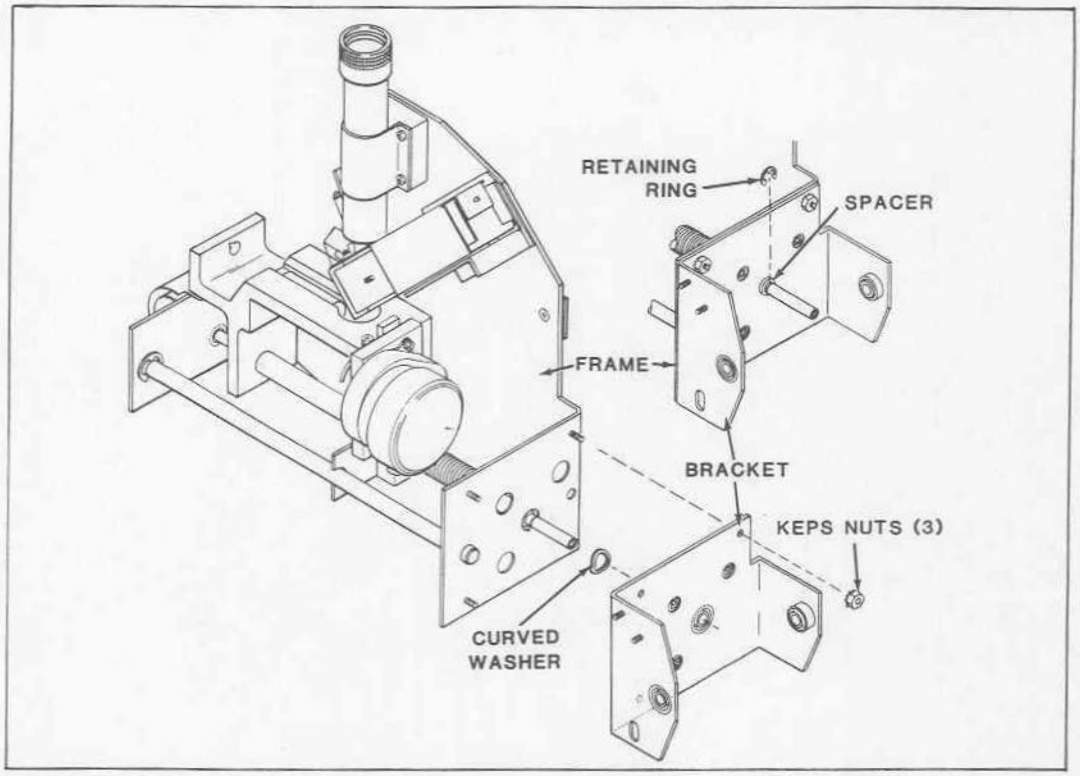


Figure 9-30. Disassembling Miter Gear Bracket Assembly from Frame Assembly

g. Remove curved washer from lead screw shaft.

h. Remove coiled shield and strap by performing Step c. of procedure in Paragraph 9.20.

i. Refer to Figure 9-31. Turn lead screw shaft until anti-rotation plate is approximately at center of lead screw threads.

j. Remove two retaining rings from inside ends of guide rod, and slide out rod from frame.

k. Holding frame with one hand, slide carriage and lead screw backward. Pull forward end of lead screw shaft out of forward bushing of frame.

l. Lower carriage assembly with attached lead screw, and gently slide complete unit out of frame.

m. Refer to Figure 9-32. Remove front and rear retaining rings from lead screw shaft.

n. Thread lead screw out of carriage assembly, and remove and save both sets of flat washers and wave washers from ends of lead screw threads.

o. Partially thread new lead screw into carriage; then install flat washers, wave washers, and retaining rings at both ends of lead screw threads (see Figure 9-32).

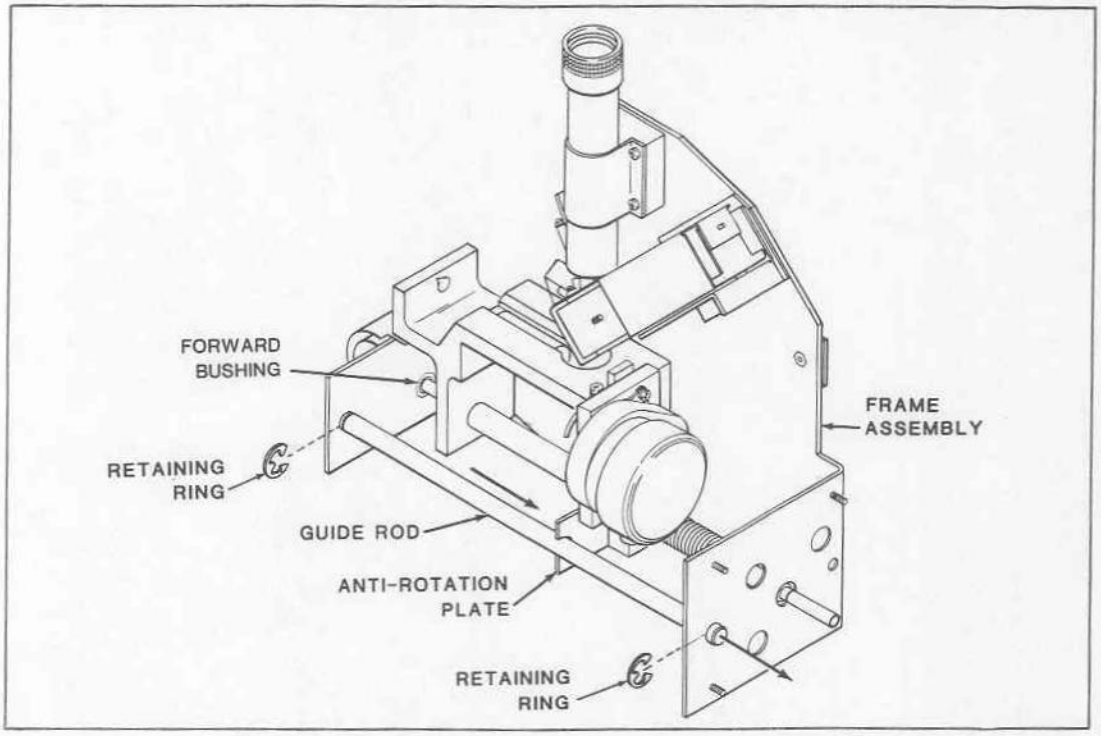

FORWARD BUSHING
FRAME ASSEMBLY
RETAINING RING
GUIDE ROD
ANTI-ROTATION PLATE
RETAINING RING

Figure 9-31. Disassembling Guide Rod from Frame

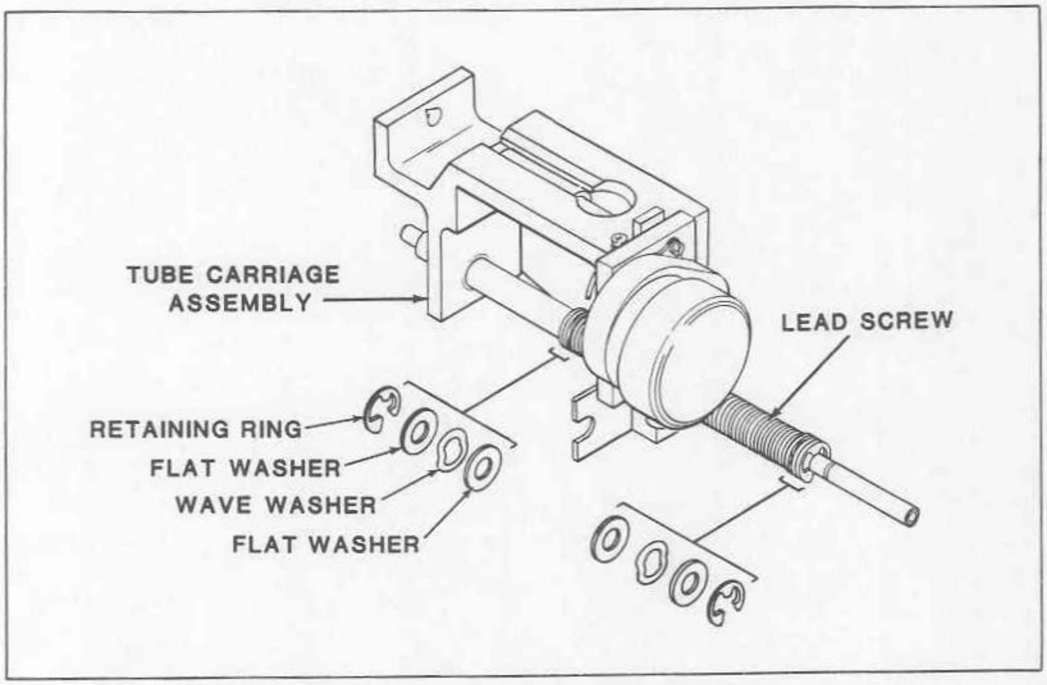

TUBE CARRIAGE ASSEMBLY
LEAD SCREW
RETAINING RING
FLAT WASHER
WAVE WASHER
FLAT WASHER

Figure 9-32. Disassembling Lead Screw from Tube Carriage Assembly

p. Thread lead screw into carriage until forward shaft is through carriage bushing.

q. Reinstall lead screw and carriage into frame.

r. Place curved washer removed in Step g. onto shaft of lead screw, through hole in frame. Be sure that inside curve of washer faces threads of lead screw.

s. Replace miter gear bracket onto frame by installing three Keps nuts removed in Step f.

t. Replace guide rod, and secure it with retaining rings removed in Step j.

u. Refer to Figure 9-33. Loosen hex screws that secure anti-rotation plate to carriage.

v. Insert 0.220-inch carriage positioning shim between frame and carriage as shown in Figure 9-34.

w. Pivot carriage until it rests against shim, then tighten hex screws to secure anti-rotation plate.

x. Insert spacer and install retaining ring on lead screw shaft.

y. Carefully insert hub of encoder disc and reticle body onto lead screw shaft, and slide both parts down to surface of miter gear bracket.

z. Refer to procedure in Paragraph 9.23. Align screw holes in reticle body with holes in bracket, and install mounting screws and washers on reticle body.

aa. Insert 0.010-inch encoder gapping shim between reticle body and disc as shown in Figure 9-35.

ab. Insert hex key into set screw in hub of disc, and lightly press hub toward mounting surface until disc rests against shim. Tighten set screw.

ac. Orient cover of encoder to clear encoder wires, then snap cover into place.

ad. Apply Glyptal to two encoder reticle body screws.

ae. Reinstall miter gears by performing Steps e. through i. of procedure in Paragraph 9.22.

af. Thoroughly lubricate lead screw in accordance with procedures in Paragraph 5.3.2.

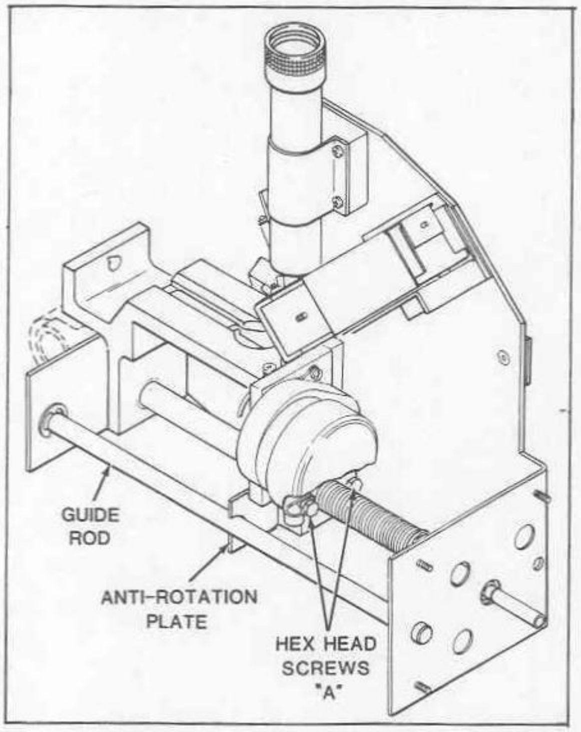

GUIDE ROD
ANTI-ROTATION PLATE
HEX HEAD SCREWS "A"

Figure 9-33. Anti-Rotation Plate Mounting Screws

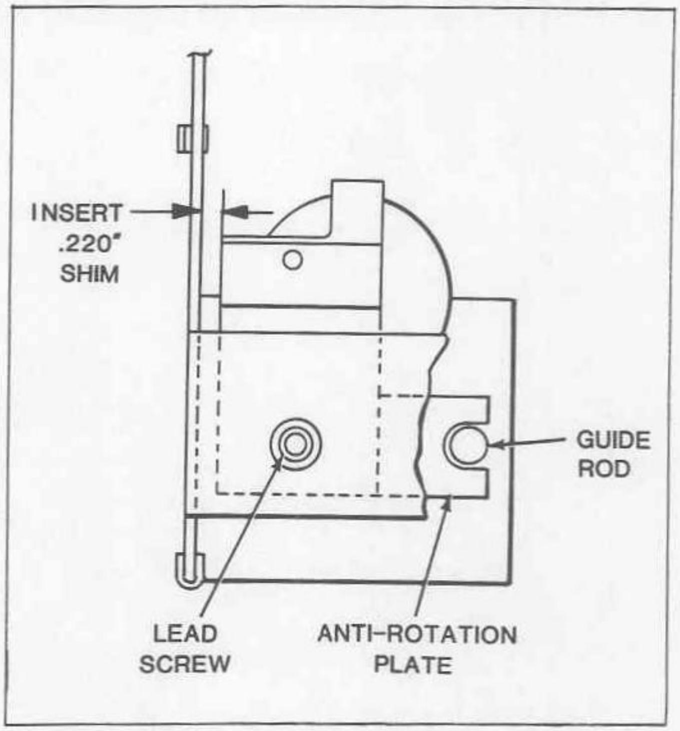

INSERT .220" SHIM
GUIDE ROD
LEAD SCREW
ANTI-ROTATION PLATE

Figure 9-34. Carriage Adjustment Gap

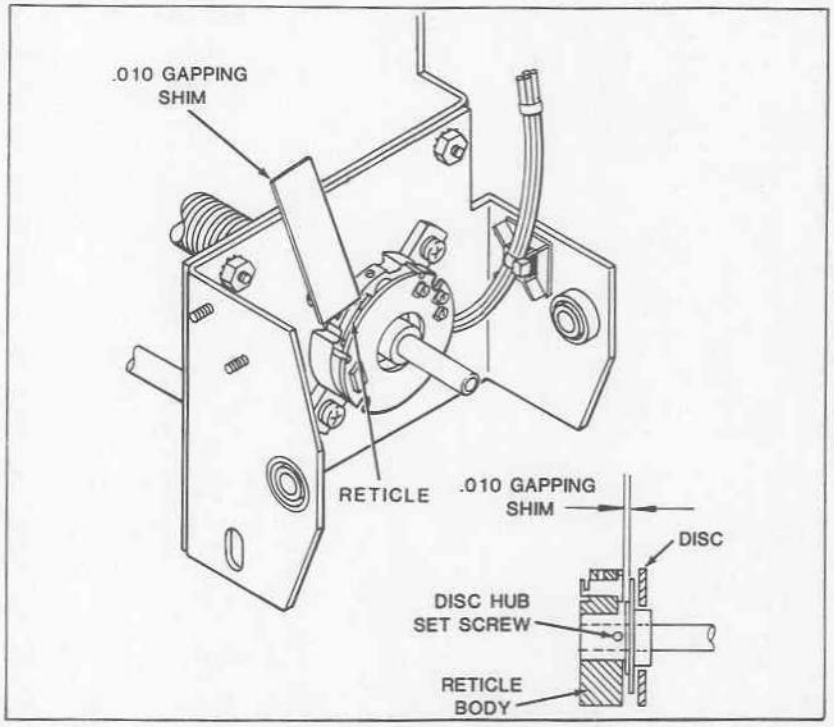

.010 GAPPING SHIM
RETICLE
.010 GAPPING SHIM
DISC
DISC HUB SET SCREW
RETICLE BODY

Figure 9-35. Gapping Reused Encoder Disc

ag. Reinstall coiled shield and carriage and optics assembly by performing Steps j., k., and m. through q. of procedure in Paragraph 9.21.

ah. Replace top cover and microscope collar.

9.25 CARRIAGE ASSEMBLY

The carriage and optics assembly must be removed from the reader, followed by disassembly of the lead screw and other components, to replace the carriage assembly:

a. Perform Steps a. through n. of procedure in Paragraph 9.24.

b. Refer to Figure 9-16. Disassemble rotator motor, mounting plate, universal joint, rotator shaft, spacer, rotator drum, and washer from carriage assembly by performing Steps a. through c. of procedure in Paragraph 9.17.

c. Using new carriage assembly, replace components removed in Step b. by performing applicable steps in Paragraph 9.17 in reverse order. Note that carriage assembly comes with preassembled thrust pivot.

> NOTE
>
> During assembly of rotator components onto new carriage, be sure to gap rotator drum and spacer by performing Steps f. through l. of procedure in Paragraph 9.17.

d. Reinstall all components by performing Steps o. through ah. of procedure in Paragraph 9.24.

9.26 SAFETY INTERLOCK SWITCH

a. Remove top cover by performing Steps a. through c. of procedure in Paragraph 9.1.

b. Refer to Figure 9-36. Remove two hex screws and lockwashers from safety switch bracket.

c. Pry connectors from switch terminals.

d. Remove safety switch from switch bracket by compressing spring clips on sides of switch and sliding switch out of bracket.

e. Install new safety switch in bracket by compressing spring clips and snapping switch into bracket.

f. Reconnect black and brown wires and two white wires to terminals of safety switch as shown in Figure 9-36.

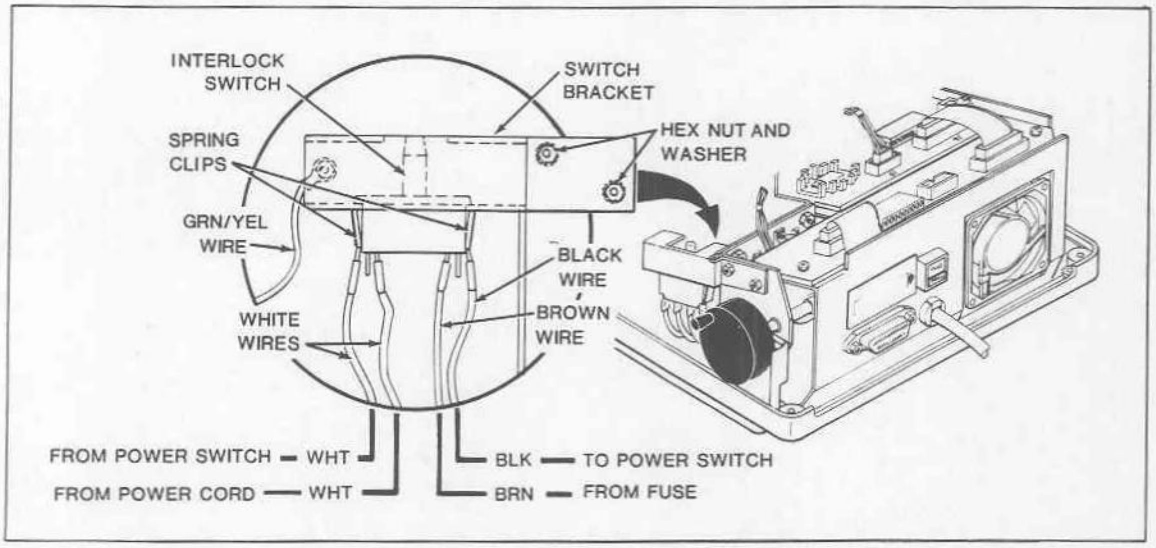

INTERLOCK SWITCH
SWITCH BRACKET
SPRING CLIPS
HEX NUT AND WASHER
GRN/YEL WIRE
BLACK WIRE
WHITE WIRES
BROWN WIRE
FROM POWER SWITCH — WHT
FROM POWER CORD — WHT
BLK — TO POWER SWITCH
BRN — FROM FUSE

Figure 9-36. Safety Interlock Switch Details

g. Replace switch bracket by installing two hex nuts and lockwashers to miter gear frame.

h. Replace top cover and microscope collar.

9.27 FAN ASSEMBLY

The computer circuit board and the printer circuit board must be removed to replace the fan assembly:

a. Remove computer circuit board and printer circuit board by performing procedures in Paragraphs 9.3 and 9.4, respectively.

b. Refer to Figure 9-37. Disconnect black fan wires from terminals 1 and 3 on TB1.

c. Remove four Keps nuts and screws from fan bracket.

d. Install replacement fan in bracket by replacing four Keps nuts and screws removed in Step c.

e. Connect black fan wires to terminals 1 and 3 on TB1.

f. Reinstall computer and printer circuit boards and display panel by performing reassembly procedures in Paragraphs 9.3 and 9.4.

g. Replace top cover and microscope collar.

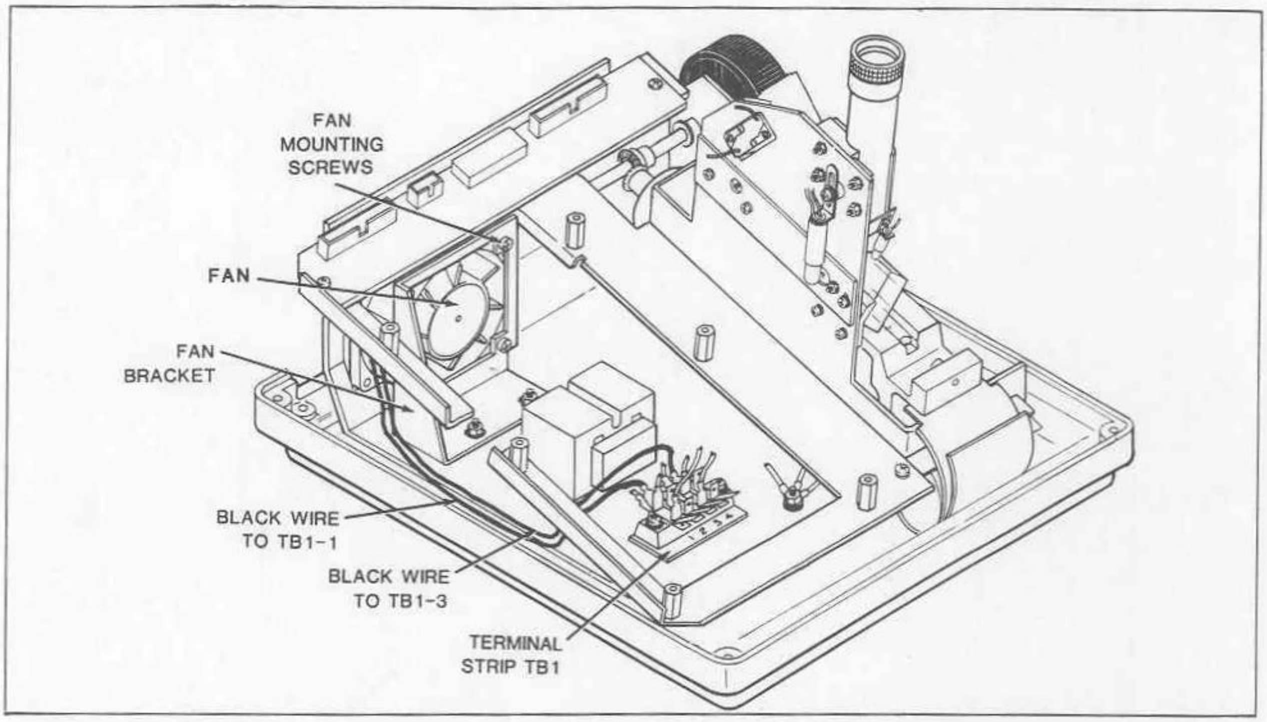


Figure 9-37. Fan Installation Details and Wiring

9.28 TRANSFORMER AND HARNESS ASSEMBLY

The computer circuit board must be removed to replace the transformer:

a. Remove computer circuit board by performing Steps a. through d. of procedure in Paragraph 9.3.

b. Refer to Figure 9-38. Disconnect black transformer wire from terminal 1 of TB1 and white transformer wire from terminal 3 of TB1.

c. Remove nut and lockwasher from ground terminal of chassis to disconnect green/yellow ground wire attached to transformer connector P1.

d. Remove two hex nuts and lockwashers that mount transformer to bottom of chassis.

e. Mount new transformer and harness assembly to bottom of chassis by replacing nuts and lockwashers removed in Step d.

f. Connect black transformer wire to pin 1 of TB1 and white transformer wire to pin 3 of TB1.

g. Connect green/yellow ground wire from transformer connector P1 to ground terminal on bottom of chassis. Attach wire to terminal with nut and lockwasher.

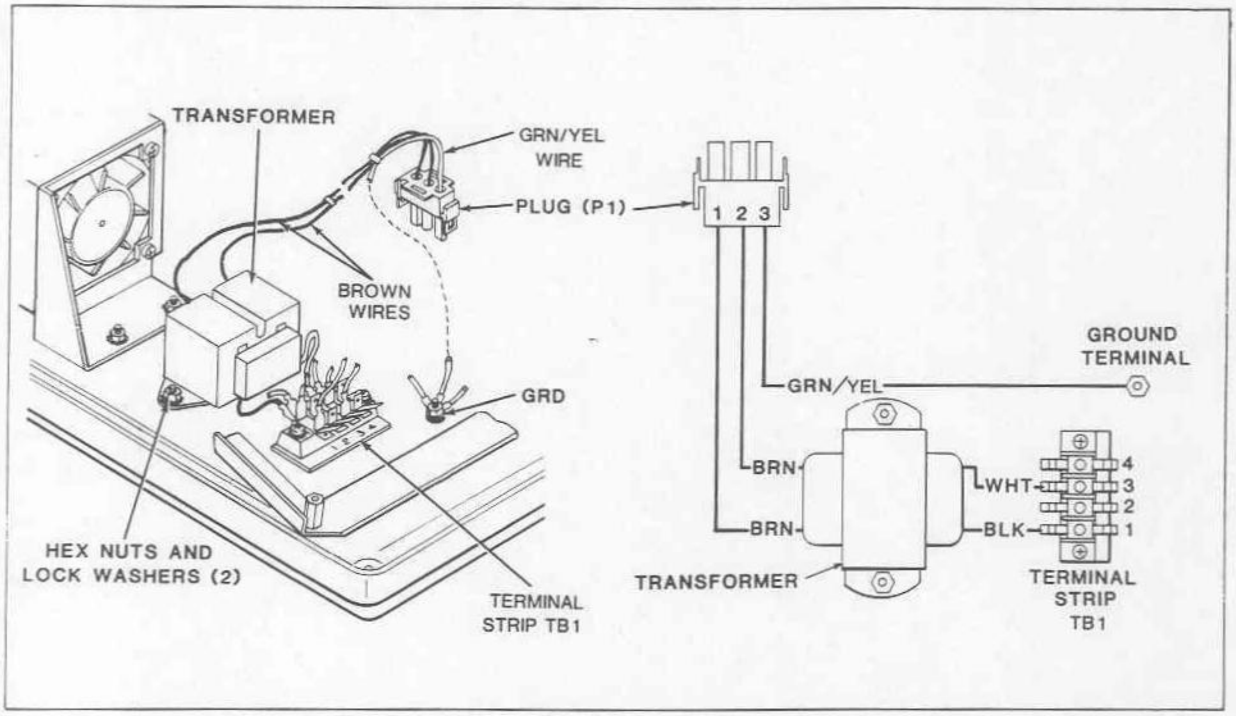

TRANSFORMER
GRN/YEL WIRE
PLUG (P1)
BROWN WIRES
GRD
HEX NUTS AND LOCK WASHERS (2)
TERMINAL STRIP TB1
1 2 3
GROUND TERMINAL
GRN/YEL
BRN
BRN
WHT
BLK
4
3
2
1
TRANSFORMER
TERMINAL STRIP TB1

Figure 9-38. Transformer Assembly and Wiring Diagram

h. Replace computer circuit board and display panel by performing Steps g. and l. of procedure in Paragraph 9.3.

i. Replace top cover and microscope collar.

9.29 CORDSET

The computer circuit board and the printer circuit board must be removed to replace the cordset:

a. Remove computer circuit board and printer circuit board by performing procedures in Paragraphs 9.3 and 9.4, respectively.

b. Disconnect cordset wires from inside reader as follows:

   1. Black wire from fuse terminal

   2. White wire from COM2 terminal of safety interlock switch

   3. Green wire from ground terminal in bottom of chassis

c. Compress Heyco bushing with pliers, and pull cordset out of hole in rear plate.

d. Using new cordset, place new Heyco bushing onto cordset approximately 1/2 inch from end of wire shielding.

e. Slide terminals of black, green, and white wires through hole in back panel, and push in wires.

f. Compress Heyco bushing, and press it into panel hole.

g. Connect cordset wires to terminals listed in Step b.

h. Replace printer circuit board, computer circuit board, and display panel by performing reassembly procedures in Paragraphs 9.3 and 9.4.

i. Replace top cover and microscope collar.

9.30 PIPETTER O-RINGS

Leakage of blood or failure of the pipetter to aspirate blood to within 1 millimeter of the fill line of the QBC venous-blood tube indicates that O-ring seals in the pipetter may be worn and should be replaced. A spare set of three O-rings as well as silicone grease are supplied with the pipetter. Replace the O-rings as follows:

a. Unscrew plastic and metal tip assembly from pipetter handle.

b. Unscrew metal retainer from plastic tip.

c. Refer to Figure 9-39. Remove small O-rings "A" and "C", and larger O-ring "B".

d. Apply heavy coat of silicone grease to small replacement O-ring, and press O-ring into shaft cavity "A."

e. Apply light coat of silicone grease to larger replacement O-ring, and slip O-ring over threaded end of plastic tip "B."

f. Apply heavy coat of silicone grease to small replacement O-ring, and insert O-ring into metal retainer cavity "C."

g. Thread retainer onto tip and finger-tighten (do not overtighten); then thread tip assembly into handle of pipetter.

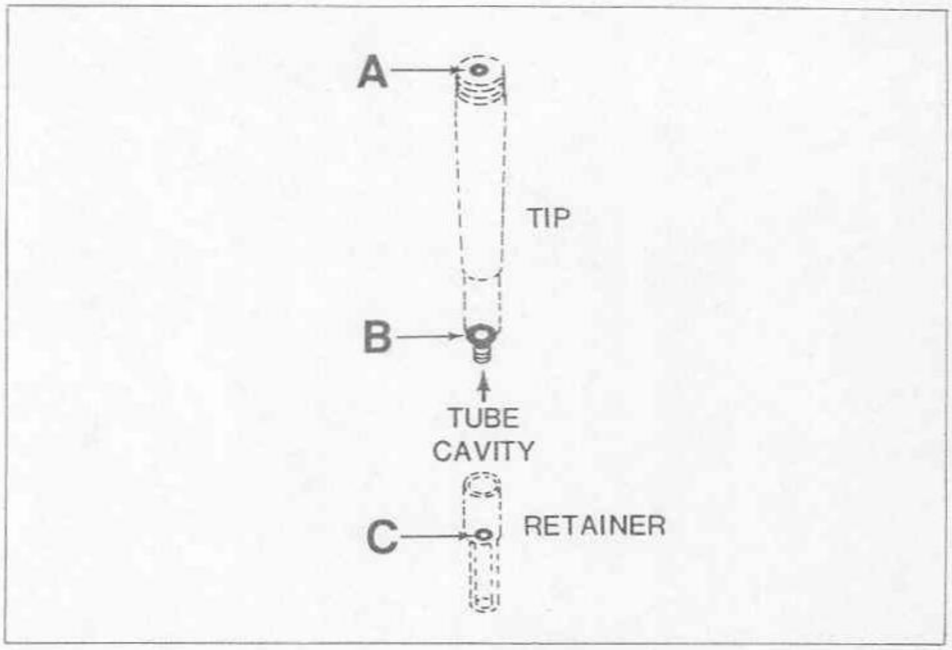


Figure 9-39. Tip Assembly, Showing O-Ring Locations

h. Insert flame-polished end of QBC venous-blood tube (end nearest two red lines) fully into tip assembly; then remove and wipe end of tube. Repeat several times to remove any excess grease from O-ring "C."

i. Unthread metal retainer from plastic tip, and wipe any grease from tube cavity (see Figure 9-39) with cotton- or rayon-tipped swab.

> CAUTION
>
> Excess grease in tube cavity may cause float in QBC blood tube to stick.

j. Reinstall retainer on tip.

Becton Dickinson
Primary Care Diagnostics
One Becton Drive, Franklin Lakes, New Jersey, U.S.A. 07417

BECTON
DICKINSON